A LABORATORY MANUAL OF THE GENERAL AND SYSTEMIC PHARMACOLOGY
(For Students of Pharmacology of Veterinary, Medical and Pharmacy Disciplines)

By

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FOREWORD

"Pharmacology" is the science that deals with the 'fate of drugs in the body' (pharmacokinetics) and 'their actions on the body' (pharmacodynamics). Therefore, there is a great scope of Pharmacology not only in the Medical Science but also in the Veterinary, Ayurvedic and Pharmacy Sciences. The important aspect is that, when a drug is applied to or introduced into a living organism has the effect of altering the body functions. Such alterations may prove the usefulness in the treatment of various diseases, or may cause disease/toxicity.

In the veterinary teaching programmes, the 'Veterinary Council of India' (VCI) has directed to include the course of 'General and Systemic Veterinary Pharmacology' under the major subject "Veterinary Pharmacology and Toxicology" for B.V.Sc. & A.H., M.V.Sc. & A.H. and Ph.D. students. Hence, the present manual titled "A Laboratory Manual of the General and Systemic Pharmacology" authored by Dr. Govind P. Pandey will be very useful practical document to those students. The exercises/experiments incorporated in this manual will undoubtedly help the teachers and research scholars as well.

I congratulate the author for his nice effort for publishing this manual. With best wishes.

Dated the 17th July, 2013

DR. S.P. SHUKLA
PREFACE

The main aim of “General Pharmacology” is to enable the students to develop a strong understanding of the process involved in the drug action. This includes the mechanisms of drug action as well as the process involved in the drug disposition. Finally, the students will be able to describe how these processes impact upon the safe and rational use of drugs. Likewise, the main objective of “Systemic Pharmacology” is to enable the students to develop a strong understanding of the use of drugs in the management of organ-specific diseases. Thus, the students will be able to know the effects of specific drugs in the context of organ systems; and the students will rationalize the use of these drugs in the context of clinical diseases affecting those organs. In all, the “Systemic Pharmacology” provides the students with information on the mechanism of drug action as it relates to specific organs and diseases. Therefore, this branch of pharmacology covers the study of drugs on systems such as cardiovascular, respiratory, gastrointestinal, endocrine systems, etc. The present manual entitled “A Laboratory Manual of the General and Systemic Pharmacology” will greatly fulfil the practical purpose of concerned students as well as the teachers.

Henceforth, all the exercises/experiments described in this manual are fruitful and resourceful for Pharmacology of Veterinary, Medical, Ayurvedic and Pharmacy sciences. The important experiments included in the manual are: pharmacy appliances; principles of compounding and dispensing; weights and measures; pharmacy calculations; pharmaceutical processes; pharmaceutical dosage forms; prescription writing; drug incompatibilities; drug standards and regulations; custody of poisons; compounding and dispensing of powders, ointments, mixtures, liniments, lotions, liquors, emulsions, electuaries and tinctures, etc.

Mean while, I feel great pleasure for having the “Foreword” written by Dr. S.P. Shukla, Dean of the College of Veterinary Science & Animal Husbandry, Rewa (NDVSU, Jabalpur), MP. I pay my sincere thank and deep regard to him. I gratefully acknowledge to the ‘Laboratory Manual for General and Systemic Veterinary Pharmacology’ (e-publication of Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India) and ‘Laboratory Manual: General & Systemic Pharmacology’ (compiled by Dr. Arpita Shrivastav, Assistant Professor, Veterinary Pharmacology and Toxicology, NDVSU, Jabalpur). I am also thankful to all other authors/publishers/books/websites, from where the matters and photographs have been taken and included in this manual; I especially acknowledge to all those. I am also cordially thankful to Dr. Nitesh Kumar, Dr. Arpita Shrivastav, Dr. Swatantra Singh and Dr. Anjana Panicker (all teachers of Veterinary Pharmacology and Toxicology in the NDVSU, Jabalpur, MP, India).

17th July, 2013

DR. GOVIND PANDEY
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INTRODUCTION TO GENERAL AND SYSTEMIC PHARMACOLOGY

OBJECTIVE

To know the general and systemic pharmacology and drugs, and their development.

MEANING AND DEFINITION OF PHARMACOLOGY

“Pharmacology” comprises of two ‘Greek words’: “pharmakon” meaning ‘drug’ or ‘poison’ and “logos” meaning the ‘study of’.

Therefore, “Pharmacology” is the science that deals with the ‘fate of drugs in the body’ (pharmacokinetics) and ‘their actions on the body’ (pharmacodynamics).

WHAT IS DRUG?

A “drug” is ‘any substance which differs from a normal constituent of the body or one that is required for normal body function (e.g., food, water, oxygen) that when applied to or introduced into a living organism has the effect of altering the body functions’.

These alterations may prove usefulness in the treatment of disease (therapeutic application), or may cause disease (toxicity).

AIM OF GENERAL PHARMACOLOGY

The chief aim of “general pharmacology” is to enable the students to develop a strong understanding of the process involved in the drug action. This includes the mechanisms of drug action as well as the process involved in the drug disposition. Finally, the students will be able to describe how these processes impact upon the safe and rational use of drugs.
AIM OF SYSTEMIC PHARMACOLOGY

The main goal of “systemic pharmacology” is to enable the students to develop a strong understanding of the use of drugs in the management of organ-specific diseases. Thus, the students will be able to: (a) know the effects of specific drugs in the context of organ systems; and (b) rationalize the use of these drugs in the context of clinical diseases affecting those organs.

Overall, the “systemic pharmacology” provides the students with information on the mechanism of drug action as it relates to specific organs and diseases. Drugs pertaining to the neuroscience, immunology, microbiology and oncology are covered and tested. Consequently, the “systemic pharmacology” covers the study of drugs on systems such as cardiovascular, respiratory, gastrointestinal, endocrine systems, etc.
DEVELOPMENT OF PHARMACOLOGY
AND MATERIA MEDICA

OBJECTIVE
To the scope and development of pharmacology and materia medica.

SCOPE OF PHARMACOLOGY
In regard to the “scope of pharmacology”, there are three major aspects of pharmacology:

- **Pharmacy** - deals with the pharmaceutical sciences and study on drug making.
- **Pharmacology** - deals with the study on drug disposition and action.
- **Toxicology** - deals with the study on poison and drug toxicity.

HISTORY/DEVELOPMENT OF PHARMACOLOGY AND MATERIA MEDICA
The history of “Materia Medica”, and then the emergence of pharmacology and therapeutics in humans have been extensively described. Appelgren in 2009 has described the early records contained: (a) in Egyptian Papyri (1800-1200 BC), the contents of which became known only from 1822 when the Rosetta Stone was translated and; (b) in the writings of the Greeks (notably Hippocrates, 430 BC) and later Galen (94 AD). Hippocrates’ and Galen’s prescriptions dominated the European medicine for many centuries, through the medieval periods, until superseded in the ‘Age of Enlightenment’. As Appelgren pointed out that the same “drugs” were used in animals and man up to and beyond the ‘Age of Enlightenment’.

The ‘origin of veterinary pharmacology and therapeutics’ are the same as those of the equivalent human disciplines, lying in the administration of and responses to plants and extracts of plants containing pharmacologically active compounds. There was,
however, at this time an expression of concern relating to the use of drugs therapeutically in animals on the basis of human experience. As voiced by the Swedish botanist and doctor Carolus Linneaus, ‘human medicines are used for animals without knowledge if they work, which is devastating barbarism’. At that time, much of the progress in veterinary medicine was made in France, and Linneaus sent Peter Hernquist to France to learn the scientific principles underlying the veterinary medicine. In 1791, Charles Vial de St. Bel left the Lyon school to find the first veterinary teaching establishment in the English speaking world, the Royal Veterinary College in London, later to become a constituent College of the University of London.

A key development in the emergence of pharmacology, from the older discipline of materia medica, was the progress in organic analytical and synthetic chemistry in the early to mid 19th century. One example will suffice to illustrate this historical development, through to the 21st century. The therapeutic properties of leaves and bark of the willow tree had been described in the 1st century AD by Dioscorides in his “Pharmacopoeia”. Many centuries prior to birth of Christ, Aristotle had similarly used the extracts of willow to ease the pain of childbirth in humans. Benefits of the willow might have remained as a small historical footnote had the Reverend Edward Stone of Chipping Norton, UK not revived the interest in his philosophical transactions to the Royal Society.

In the first half of the 19th century, the chemists isolated from the willow a glycoside, saligenin, one component of which was shown in 1830 to be salicylic alcohol. Recognizing this as the active principle of saligenin, the chemists converted this to salicylic acid and then to its sodium salt. Finlay, Dun in 1895 described the therapeutic value of sodium salicylate in horse and dog, for its analgesic action in joint diseases. We now know that the pathology of degenerative joint disease in these species shares many common features with that occurring in the ageing human population, and that the natural wear and tear process is accelerated by extreme activity or sub-optimal conformation. In 1898, Felix Hoffmann of the Bayer Pharmaceutical Company described the use of the acetyl ester of salicylic acid (aspirin) in his arthritic father and the next phases through to the 21st century led to the introduction of successive agents of the non-steroidal antiinflammatory drug (NSAID) class. However, it was not until 1971 that Vane (1971)
discovered the main mechanism of action of NSAIDs to be inhibition of cyclooxygenase (COX), an enzyme which converts the substrate arachidonic acid to a range of locally acting autacoids, described under the collective term eicosanoids. The eicosanoids possess a wide range of properties that include the generation de novo of compounds, e.g., prostaglandins (PG) E$_2$ and I$_2$, which exert crucial roles as mediators of the acute inflammation, notably in the phenomenon of hyperalgesia, through both local and central actions. It was not until 1991 that discovery of two COX isoforms, COX-1 and COX-2, led to the concept that the former was involved primarily in a range of protective roles, while the latter was involved mainly in generating inflammatory mediators.

Veterinary medicine faces the unique challenge of having to treat many types of domestic animal species, including mammals, birds and fishes. Moreover, these species have evolved into genetically unique breeds having certain distinguishable characteristics developed by artificial selection. The main challenge for veterinarians is not to select a drug but to determine, for the selected agent, a rational dosing regimen because the dosage regimen for a drug in a given species may depend on its anatomy, biochemistry, physiology and behaviour as well as on the nature and causes of the condition requiring treatment. Both between- and within-species differences in drug response can be explained either by variations in drug pharmacokinetics or drug pharmacodynamics, the magnitude of which varies from drug to drug. After the administration of drug, the main causes of observed inter-species differences arise from species differences in the handling of drugs (absorption, distribution, metabolism and elimination). Such differences are most common and of greatest magnitude when functions which are phylogenetically divergent between species like digestive functions (ruminant vs. non-ruminant; carnivore vs. herbivore; etc.), are involved in drug absorption. The inter-species differences also exist in drug action but these are generally more limited, except when a particular targeted function has evolved, as is the case for reproductive physiology (mammals vs. birds vs. fishes; annual vs. seasonal reproductive cycle in mammals; etc.). In contrast, for antimicrobial and antiparasitic drugs, inter-species differences are more limited and rather reflect those of the pathogens than of the host. The inter-species difference in the drug metabolism is a major factor accounting for species differences in pharmacokinetics.
and also in pharmacodynamics (production or not of active metabolites). Recent and future advances in molecular biology and pharmacogenetics will enable a more comprehensive view of inter-species differences and also between breeds with existing polymorphism. Therefore, each drug must be investigated on a species-by-species basis to guarantee its effective and safe use, thus ensuring the well-being of animals and safeguarding of the environment and human consumption of animal products.

In veterinary medicine, the transition from materia medica to veterinary pharmacology occurred slowly from the early to mid 20th century. The discoveries and introduction into veterinary therapeutics of sulphonamides, benzylpenicillin, and then the streptomycin as antimicrobial drug, of NSAIDs like phenylbutazone, of sedatives such as acepromazine, of volatile anaesthetics such as halothane and of injectable anaesthetics of barbiturate class laid the early foundations of veterinary pharmacology and therapeutics in the period 1930 to 1960. Nevertheless, at the time of appointment of one of the editors to the staff of the Royal Veterinary College in 1964, there remained in widespread use of older drugs. These included phenothiazine (as an anthelmintic), carbon tetrachloride (as a treatment for liver fluke infestation), chloral hydrate (as a sedative), chloroform (as an anaesthetic), a range of digitalis glycosides (for the control of congestive heart failure) and organomercurials (as diuretics), all of questionable efficacy and/or low safety in clinical use.

More than 50 years of period (from 1960), veterinary pharmacology and therapeutics have been transformed. This has occurred first through major advances in the understanding of disease (both infectious and non-infectious) mechanisms at molecular, cellular, organ and whole animal levels and secondly (and in consequence) through the introduction of drugs with increasingly selective actions. In parallel, the identification of drug action at receptor and enzyme levels has led to improved targeting of therapeutic agents. The veterinary pharmacologist has taken the advantage of new knowledge in the basic science that leads to drug discovery. Often the drugs have been developed for human clinical use before they have been investigated in veterinary clinical patients. The safety and efficacy cannot be assumed to apply across the species (e.g., $\alpha_2$-adrenoceptor agonist drugs lack sedative efficacy in pigs; ibuprofen has a very narrow therapeutic
index in dogs) and careful study in each individual species is required. Similarly, some
drugs discarded at an early stage of development for human medicine prove to be highly
efficacious and safe in some veterinary clinical patients, e.g., milrinone in treating dilated
cardiomyopathy in dogs. The beneficial result has been the introduction of many novel
drugs with increased efficacy and reduced toxicity for human and veterinary use. About
95% or more of drugs now in widespread clinical use were undiscovered during 1960s.
SOME PHARMACOLOGICAL TERMS/DEFINITIONS

OBJECTIVE

To know some terms/definitions applicable in general and systemic pharmacology.

SOME TERMS/DEFINITIONS OF PHARMACOLOGY

Affinity:

This is the equilibrium constant of the reversible reaction of a drug with a receptor to form a ‘drug-receptor complex’; the reciprocal of the dissociation constant of a drug-receptor complex.

Agonist:

This is a ligand which binds to a ‘receptor’ and alters the receptor state, resulting in a biological response. The agonist may be:

(a) **Full agonist**- This type of agonist produces the largest maximal response of any known agonist that acts on the same receptor.

(b) **Partial agonist**- This type of agonist produces a maximal response that is less than the maximal response produced by another agonist acting at the same receptor on the same tissue, as a result of lower intrinsic activity.

(c) **Inverse agonist**- This is a ligand which, by binding to a receptor, reduces the fraction of receptor in an active conformation, thereby reducing the basal activity. This can occur if some of the receptors are in the active form in the absence of a conventional agonist.
**Antagonism:**

The combined effect of two or more drugs is such that the combined effect is less than the sum of the effects produced by each drug separately. The agonist is the agent producing the effect that is diminished by the administration of antagonist.

**Area Under Plasma Concentration:**

This is the area under the plot of plasma concentration (AUPC) of drug (not logarithm of the concentration) against time after drug administration. The area is conveniently determined by the ‘trapezoidal rule’, i.e., the data points are connected by straight line segments; perpendiculars are erected from the abscissa to each data point; and the sum of the areas of the triangles and trapezoids so constructed is computed.

**Bioassay or Biological Assay:**

This is the determination of the potency of a physical, chemical or biological agent, by means of a biological agent, or by means of a biological indicator. The biological indicators in bioassay are the reactions of living organisms or tissues.

**Bioavailability:**

This is the per cent (%) of dose entering the systemic circulation after the administration of a given dosage form.

**Biopharmaceutics:**

This is the science and study of the ways in which the pharmaceutical formulation of administered agents can influence their pharmacodynamic and pharmacokinetic behaviour.

**Biotransformation:**

This is a chemical alteration of an agent/drug which occurs by virtue of the sojourn of the agent/drug in a biological system.
**Biotranslocation:**

This is the movement of chemicals/drug into, through and out of biological organisms or their parts.

**Ceiling:**

This is the maximum biological effect which can be induced in a tissue by a given drug, regardless of how large a dose is administered.

**Clearance:**

The clearance of a chemical is the volume of body fluid from which the chemical is, apparently, completely removed by the biotransformation and/or excretion, per unit time.

**Compartment:**

The compartment is the space in the body, in which a drug appears to occupy after it has been absorbed.

**Compliance:**

This is extent to which a patient agrees to and follows a written treatment regimen.

**Dependence:**

This is a somatic state which develops after the chronic administration of certain drugs. This state is characterized by the necessity to continue administration of the drug in order to avoid the appearance of uncomfortable or dangerous (withdrawal) symptoms.

**Desensitization:**

This is a decline in response to the repeated or sustained application of an agonist that is a consequence of changes at the level of the receptor.

**Disintegration Time:**

This is the time required for a tablet to break up into granules of specified size (or
smaller), under carefully specified test conditions.

**Dissolution Time:**

This is the time required for a given amount (or fraction) of drug to be released into the solution from a solid dosage form.

**Dose:**

This is the quantity of a drug/dosage form, administered to a subject at a given time.

**Dose-Duration Curve:**

This is the curve, describing the relationship between dose (as the independent variable) and duration of the drug effect (as the dependent variable, T).

**Drug:**

In general, a “drug” is a non-food physical material which alters an organism’s normal functioning by affecting the physiologic processes. Pharmacologically or medically, a “drug” is:

1. a chemical substance which affects the processes of the mind or body; or
2. any chemical compound used in the diagnosis, treatment, or prevention of a disease or other abnormal conditions; or
3. a substance used recreationally for its effects on the central nervous system (CNS), e.g., narcotic; or
4. any substance taken by mouth, injected into the body (muscle, skin, blood vessel or cavity), or applied topically to treat or prevent a disease/condition; or
5. any substance which can be abused for its stimulant, depressant, euphoric or hallucinogenic effects.

**Drug Abuse:**

Use of a drug, whether over the counter or prescription, for purposes other than those prescribed on the product label, often for recreational reasons is called the “drug abuse”.
**Drug Dosage Form/Dosage Form:**

This is the physical state in which a drug is dispensed for use.

**Drug Interaction:**

This is a negative (occasionally positive) health consequence arising from the ways in which drugs, herbs, medications and nutritional supplements interact with each other when taken concurrently. Such interactions arguably represent the largest risk when taking multiple medications and/or supplements.

**Dummy:**

This is ‘a counterfeit object’, i.e., a form of treatment (as in an experimental investigation of drug effects) which is intended to have no effect, to be biologically inert considered ‘more destructive than constructive for the society and the individual’.

**Efficacy:**

Generally, the “efficacy” refers to the capacity of a drug to produce an alteration in a target cell/organ after binding to its receptor. A competitive antagonist, which occupies a binding site without producing any alteration in the receptor, may have zero efficacy.

**Eqipotent:**

This term refers to as the ‘equally potent, or equally capable of producing a pharmacologic effect of a specified intensity’. The masses of the drugs required to produce this degree of effect may be compared (quantitatively) to yield the estimates of ‘potency’ of the drugs.

**Chemical Equivalent:**

The “chemical equivalents” are those multiple-source drug products which contain essentially identical amounts of the identical active ingredients, in identical dosage forms, and which meet the existing physico-chemical standards in the official compendia. The chemical equivalent is of two kinds:
(a) Biological equivalent- It is that chemical equivalent which, when administered in the same amounts, will provide essentially the same biological or physiological availability, as measured by blood levels, etc.

(b) Clinical equivalent- It is that chemical equivalent which, when administered in the same amounts, will provide essentially the same therapeutic effect as measured by the control of a symptom or a disease.

First Pass Effect:
This is the biotransformation and/or excretion of a drug by intestinal and hepatic, including biliary, mechanisms following absorption of the drug from the gastrointestinal tract (GIT), before the drug gains access to the systemic circulation.

Generic Drug:
This is the drug formulation of identical composition with respect to the active ingredient, i.e., drug which meets the current official standards of identity, purity and quality of active ingredient.

Half-Life:
This is the period of time required for the concentration, or the amount of drug in the plasma (body) to be reduced to exactly one-half of a given concentration or amount.

Hazard:
This is the potential for causing harm, or the “hazard” is a potential cause of harm. With respect to the chemicals which are capable of causing harm, the “hazard” is about equivalent in meaning to the “toxicity”. Measuring the hazard or toxicity of a chemical is to measure its potency in producing the harm: the lower the dose required to produce the harm, the greater the hazard or toxicity, the more hazardous or toxic is the substance.

Idiosyncrasy/Idiosyncratic Response:
This is a qualitatively abnormal or unusual response to a drug which is unique, or
virtually so, to the individual who manifests the response. The “idiosyncratic response” normally applies to a response which is not allergic in nature and can not be produced with regularity in a substantial number of subjects in the population, and which is generally not produced in a greater fraction of the population, by the expedient of increase in the dose.

**Infusion:**

This is a means of drug administration which involves an effectively continuous flow of a drug solution into the blood stream over a relatively long period of time.

**Intrinsic Activity/Intrinsic Efficacy:**

This is the property of a drug which determines the amount of biological effect produced per unit of ‘drug-receptor complex’ formed.

**Latency/Latent Period:**

This is period of time which must elapse between the time at which a dose is applied to a biologic system and the time at which a specified pharmacologic effect is produced.

**Loading Dose:**

This is a larger dose \( (D^*) \) as compared to the normal dose administered as the first in a series of doses, the others of which are smaller than \( D^* \) but equal to each other. The “loading dose” is administered in order to achieve a therapeutic amount in the body more rapidly than would occur only by accumulation of the repeated smaller doses.

**Maintenance Dose:**

The smaller dose (D) which is given after the loading dose \( (D^*) \) is called “maintenance dose”.

**Median Effective Dose:**

This is the dose of a drug predicted (by statistical techniques) to produce a
characteristic effect in 50% of the subjects to whom the dose is given.

**Median Lethal Dose/Median Lethal Concentration/Median Lethal Concentration and Time:**

In toxicology, the “median lethal dose” \( (LD_{50} \text{ or ‘lethal dose, 50%’}) \), “median lethal concentration” \( (LC_{50} \text{ or ‘lethal concentration, 50%’}) \) or “median lethal concentration and time” \( (LCt_{50} \text{ or ‘lethal concentration & time’}) \) of a toxin, radiation or pathogen is the dose required to kill half the members of a tested population after a specified test duration. The \( LD_{50}/LC_{50} \) is used as a general indicator of a drug’s acute toxicity. The test for \( LD_{50} \) was created by J.W. Trevan in 1927. The term ‘semilethal dose’ is rarely used with the same meaning, in particular in translations from non-English-language texts, but can also refer to a ‘sublethal dose’. Because of this ambiguity, the term ‘semilethal dose or sublethal dose’ is generally not used. The \( LD_{50} \) is usually determined by the tests on animals like laboratory rats and mice. In 2011, the US Food and Drug Administration (FDA) approved the alternative methods to \( LD_{50} \) for testing the cosmetic drugs.

\( LD_{50} \) is usually expressed as the mass of substance administered per unit mass of the test subject, as ‘milligrams of substance per kilogram of body mass’ \( (mg/kg \text{ body weight}) \), but is stated as nanograms (suitable for botulinum), micrograms, milligrams or grams (suitable for paracetamol) per kilogram as toxicity decreases. Stating it this way allows the relative toxicity of different substances to be compared, and normalizes for the variation in the size of the animals exposed (although toxicity does not always scale simply with body mass).

**Multiple Dose Regimen:**

This is the pharmacokinetic aspects of treatment schedules which involve more than one dose of a drug.

**Pharmaceutical Preparation:**

By this, the drugs are intended for human or veterinary use, presented in their finished dosage form. In this, the materials used in the preparation and/or formulation of
the finished dosage form are also included.

**Placebo:**

The term “placebo” is a *Latin* word, meaning ‘*I will satisfy*’. Thus, the “placebo” is a medicine or preparation with no inherent pertinent pharmacological activity which is effectively only by virtue of the factor of suggestion attendant upon its administration.

**Potency:**

This is an expression of the activity of a drug, in terms of the concentration or amount needed to produce a defined effect.

**Potentiation:**

This is a special case of synergy in which the effect of one drug is increased by another drug, that by itself, has no effect.

**Prodrug:**

This is a chemical with little or no pharmacologic activity which undergoes change in the body into a more active material.

**Receptor:**

This is actual or hypothetical the small, chemically defined area of a cell which gives (initiates) a biological response upon uniting with chemically complementary area of natural or foreign molecule(s)/drug(s).

**Reference Standard:**

This is a drug, chemical or dosage form, etc. of specified properties used as the basis for quantitative comparison with other materials of qualitatively similar properties.

**Selectivity:**

This is the capacity or propensity of a drug to affect one cell population in preference
to others, i.e., the ability of a drug to affect one kind of cell and produce effects in doses lower than those required to affect the other cells.

**Sensitivity:**

This is the ability of a population, an individual or a tissue, relative to the abilities of others, to respond in a qualitatively normal fashion to a particular drug dose. The smaller the dose required to produce an effect, the more sensitive is the responding system.

**Side Effect:**

This is the drug effect which is not desirable or is not part of a therapeutic effect; the effect other than those intended.

**Specificity:**

This is the capacity of a drug to manifest only one kind of action.

**Supersensitivity:**

This is an extreme and high degree of sensitivity to a drug or chemical. Generally, a high degree of sensitivity is induced by some specific procedures like denervation, administration of another drug, etc.

**Synergy/Synergism:**

“Synergy” is the interaction of multiple elements in a system to produce an effect different from, or greater than the sum of their individual effects. The term “synergy” comes from the Greek word ‘synergia’ (synergos), meaning ‘working together’. In other words, the “synergy” is a mutually reinforcing drug interaction as the joint effect of two drugs administered simultaneously is greater than the sum of their individual effects. The process of synergy is known as the “synergism”.

“Drug synergy/synergism” can occur both in biological activity and because of pharmacokinetics. The shared metabolic enzymes can cause drugs to remain in the bloodstream much longer in higher concentrations than if individually taken. The drug

synergy occurs when drugs can interact in ways that enhance or magnify one or more effects, or side effects, of those drugs. This is sometimes exploited in combination preparations, e.g., codeine mixed with acetaminophen or ibuprofen to enhance the action of codeine as a pain reliever. Other examples include the use of cannabis with LSD, where the active chemicals in cannabis have been reported to enhance the hallucinatory experience of LSD. The negative effects of synergy are a form of contraindication. For example, a combination of depressant drugs which affect the CNS, such as alcohol and valium, can cause a greater reaction than simply the sum of the individual effects of each drug if they were used separately. In this particular case, the most serious consequence of drug synergy is exaggerated respiratory depression, which can be fatal if left untreated. Mixing of drugs can produce potentially fatal reactions within the brain, like serotonin syndrome, due to synergistic reactions changing chemical and receptor activity. In the case of monoamine oxidase inhibitor (MAOI) medications, mainly used as last-straw antidepressants, the mixing certain foods and drugs may cause hypertension or hyperserotonemia.

**Tachyphylaxis:**

This is a decline in response to the repeated applications of agonist, typically occurring over a relatively short time scale (seconds to hours).

**Therapeutic Index:**

“Therapeutic index” (also called ‘therapeutic ratio’) is a comparison of the amount of a therapeutic agent that causes the therapeutic effect to the amount which causes ‘death’ (in animal studies) or ‘toxicity’ (in human studies).

Quantitatively, the “therapeutic index” is the ratio given by the ‘lethal or toxic dose’ divided by the ‘therapeutic dose’. In animal studies, the “therapeutic index” is the lethal dose of a drug for 50% of the population (LD$_{50}$) divided by the minimum effective dose for 50% of the population (ED$_{50}$).

‘Lethality’ is not determined in human clinical trials; instead, the dose which produces a toxicity in 50% of the population (TD$_{50}$) is used to calculate the “therapeutic

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index”. While the lethal dose is important to determine in animal studies, there are usually severe toxicities which occur at sublethal doses in humans, and these toxicities often limit the maximum dose of a drug. A higher therapeutic index is preferable to a lower one: a patient would have to take a much higher dose of such a drug to reach the lethal/toxic threshold than the dose taken to elicit the therapeutic effect. Therefore-

for animal: Therapeutic index = LD50 / ED50

for human: Therapeutic index = TD50 / ED50

Usually, a drug or other therapeutic agent with a narrow therapeutic range (i.e., having little difference between toxic and therapeutic doses) may have its dosage adjusted according to measurements of the actual blood levels achieved in the person taking it. This may be achieved through the therapeutic drug monitoring (TDM) protocols. The “therapeutic index” varies widely among substances: most forgiving among the opioid analgesics is remifentany, which offers a “therapeutic index” of 33,000:1; tetrahydrocannabinol (a sedative and analgesic obtained from the Cannabis herb) has a safe therapeutic index of 1000:1; while diazepam (a benzodiazepine sedative-hypnotic and skeletal muscle relaxant) has a less-forgiving index of 100:1; and morphine (a sedative, antidepressant and analgesic obtained from the Papaver plant) has an index of 70:1 (which, however, is still considered very safe).

**Therapeutics:**

This is the science and techniques of restoring the patients to health. Therapeutics may have the following kinds of therapy:

(a) **Curative or specific therapy**- By this, the treatment is directed towards the eradication of one or more of the agencies aetiologic to the patient’s condition. The antimicrobial drugs (e.g., penicillin) have specific or curative effects.

(b) **Palliative or symptomatic therapy**- By this, the treatment is directed only towards the relief of the patient’s symptoms, towards making the patient feel better without necessarily altering the natural course of the disease. The analgesic agents (e.g., aspirin, morphine, etc.) have obvious palliative effects.

(c) **Supportive therapy**- By this, the treatment is directed towards maintaining the
patient’s physiological or functional integrity until more definitive treatment can be carried out, or until the patient’s recuperative powers function to obviate the need for further treatment. Many drugs can provide the supportive therapy. Even in a single patient, the supportive therapy can be provided from the drugs of such different classes like the sedatives, diuretics, antihypertensives, etc.

(d) **Substitutive or replacement therapy**- By this, the treatment is directed towards the supplying a material normally present in the body, but absent in a specific patient because of disease, injury, congenital deficiencies, etc. The adrenocortical hormones used in the treatment of a patient with Addison’s disease are used as the substitutive therapy.

(e) **Restorative therapy**- This therapy is directed at the rapid restoration of health, usually regardless of the nature of the original disease. The restorative therapy is most frequently given during convalescence. Vitamin supplements or sex hormones used for their anabolic effects might be considered as providing the restorative therapy.

**Threshold Dose:**

This is a dose of drug just sufficient to produce a pre-selected effect. Frequently, and improperly, it is restricted to the dose just sufficient to produce a detectable effect.

**Time-Concentration Curve:**

This is the graphical representation of the relationship for a given drug and a given biological system- between the concentration (or dose) and latency or latent period: the period of time elapsing between the time the dose is administered and the time a given effect is produced. The “time-concentration curve” tends to be hyperbolic in form: as dose increases, the latency decreases and vice-versa.

**Tolerance:**

This is a condition characterized by a reduced effect of a drug upon the repeated administration.
**Toxic Effect:**
This is the response to drug which are harmful to the health or life of the individual. The toxic effects may be idiosyncratic or allergic in nature, or pharmacologic side effects, or may be an extension of therapeutic effect produced by the over dosage.

**Toxicity:**
“Toxicity” is the state or quality of being poisonous or capable of causing harm to the exposed humans or animals. On the other hand, “toxicity” is the degree to which a substance is poisonous or can cause harm to the exposed humans or animals.

In the context of pharmacology, the “toxicity” occurs when a person/animal has accumulated too much of a drug in the bloodstream, leading to the adverse effects within the body. The ‘drug toxicity’ may occur when the dose given is too high, or the liver or kidney is unable to remove the drug from the bloodstream, allowing the drug to accumulate in the body.

**Withdrawal Syndrome:**
This is a group of symptoms of variable severity which occur on the cessation or reduction of drug use after a prolonged period of use and/or in high doses.
PHARMACY AND ITS APPLIANCES

OBJECTIVE
To know the pharmacy and its appliances for different experiments.

PHARMACY
“Pharmacy” is the branch of pharmacology which deals with the art and science of collection, preparation, standardization, compounding and dispensing of drugs in suitable dosage forms for therapeutic use in humans or animals.

The old term “Materia Medica” (means medicinal substances) is comprised of pharmacy, pharmacognosy, posology and medicinal properties/therapeutic utility of medicinal substances.

Pharmacy includes:
1. Pharmacognosy- means the identification of botanical source of drugs. It is an integral part of pharmacy which deals with the source of drugs and their physical and chemical characters.

2. Pharmaceutical Chemistry- deals with the synthesis of new drugs either as modifications of older or natural drugs, or as entirely new chemical entities.

3. Biopharmaceutics- is the study of the ways in which the pharmaceutical formulation of administered agents can influence their pharmacodynamic and pharmacokinetic behaviours.

APPLIANCES OF PHARMACY LAB
The important basic appliances/equipments/instruments/glasswares/materials required in a pharmacy laboratory are as under:

1. Analytical instruments- Spectrometer (Fig. 1), chromatography (Fig. 2), analgesiometer (Fig. 3), rotarod (Fig. 4), etc.
2. Physical balance (Fig. 5)
3. Chemical balance (Fig. 6)
4. Bulk balance (Fig. 7)
5. Analytical balance (Fig. 8)
6. Weights (Fig. 9)
7. Graduates- Conical graduate (Fig. 10) and cylindrical graduate (Fig. 11)
8. Mortars and pestles- metallic, wedgewood, glass, marble or porcelain make (Fig. 12)
9. Spatulas- stainless steel, pill spatula or rubber make (Fig. 13)
10. Powder knives (Fig. 14)
11. Spirit lamps (Fig. 15)
12. Tripod stands
13. Water baths (Fig. 16)
14. Filter papers
15. Funnels
16. Beakers- 50, 100, 200 and 400 ml volumes (Fig. 17)
17. Measuring cylinders- 25, 50 and 100 ml volumes (Fig. 18)
18. Gallipots- 100, 200 and 500 ml volumes (Fig. 19)
19. Wide and narrow mouthed dispensing bottles (Fig. 20)
20. Dispensing vials (Fig. 21)
21. Glass rods (Fig. 22)
22. Ointment jars (Fig. 23)
23. Ointment slabs (Fig. 24)
24. Droppers
25. Micropipettes and tips (Fig. 25)
26. Disposable syringes and needles (Fig. 26)
27. Tuberculin syringes and needles (Fig. 27)
28. Pill boxes (Fig. 28)
29. Pill tiles (Fig. 29)
30. Gelatin capsules (Fig. 30)
31. Hand scales (Fig. 31)
32. Pillar scales (Fig. 32)
33. Scissors (Fig. 33)
34. Mouth gags (Fig. 34)
35. Stomach tubes (Fig. 35)
**Bulk Balance**- The bulk balance or counter balance is less accurate than the ‘Class A prescription balance’, and is primarily used to weigh the large quantities of material. It has a limit of 5 kg and a sensitivity of 100 mg.

**Analytical Balance**- With the advent of new technology, the analytical balance is finding its way from pharmaceutical analytical laboratory in the pharmacy setting. Due to convenience, the precision and accuracy, as well as a sensitivity of a digital readout of 0.1 mg, most pharmacies prefer the use of this balance.

**Weight**- The weight is used for the ‘Class A prescription balance’ and other balances
made of brass or polished metal, and must be maintained and handled properly. These sets usually contain cylindrical weights ranging from 1 to 50 g and fractional weights of 10 to 500 mg. Once yearly, the weights should be calibrated to ensure accuracy.

Spatula- The spatula is used to transfer solid ingredients, e.g., powders, ointments, creams to weighing pans. The spatulas are also used to mix ingredients together into the homogenous mixtures. The spatulas are available in stainless steel, plastic and hard rubber. The type of spatula to be used is dependent on what is being transferred or mixed.

Mortar and Pestle- The mortar and pestle are used to grind the particles into fine powders (trituration). The incorporation of a liquid (levigation) can further reduce the particle size. The mortar and pestle are made of glass, metal, wedgewood, porcelain or marble. The glass-made mortar and pestle are preferable for mixing liquid and semi-soft dosage forms.

Graduate- This is used for the measurement of liquids. The ‘conical graduate’ has a wide mouth and wide base to allow the stirring of liquids with a glass-stirring rod. As the diameter of graduate increases, the accuracy decreases. The conical graduate varies in size from 10 to 4000 ml.

The ‘cylindrical graduate’ is uniform from top to bottom, and is the most accurate graduate for the measurement of liquids.

ARRANGEMENTS/FITTINGS OF PHARMACY APPLIANCES

- In the pharmacy lab, there should be sufficient light and space.
- The pharmacy table should face window, while the racks and almirah should be arranged behind the dispensary.
- The racks and almirah should be kept in such a way that it could be within the reach, and by doing so, the floor can be cleaned easily.
- There should be sufficient availability of water in the pharmacy lab.
- There must be good and proper fittings/keepings of all the equipments/instruments/appliances/glasswares required for different experiments of the general and systemic pharmacology.
WEIGHTS AND MEASURES

OBJECTIVE
To study the weights and measures used in different experiments.

METROLOGY AND POSOLOGY
Weights and measures in a single word are named as “Metrology”. Hence, metrology is the science which deals with the study of scales of weights and measures used in the ‘prescription writing’.

Whereas, “Posology” is the science which deals with the drug dosage protocols.

SYSTEMS OF METROLOGY (WEIGHTS AND MEASURES)
Metrology comprises of three different systems:
1. Imperial or Avoirdupois system
2. Troy or Apothecary system
3. Metric system (Systeme Internationale, SI)

1. Imperial or Avoirdupois System:
It is the official system of weights and measures in the United States for normal commodities. This system is in general use for commercial purposes including the wholesale purchase and sale of drugs on a large scale. It is not used for taking minor quantities of drugs, as this system does not recognize weight denominations between one ‘grain’ (gr.) and one ‘ounce’ (oz).

The ounce and ‘pound’ (lb) weights of this system also differ from those of Apothecary system. The Avoirdupois numerals are written in Arabic figures and figures are followed by the correct abbreviations of the denominations.

Between the two systems, ‘Avoirdupois ounce’ is smaller than the ‘Apothecary
ounce’. The pharmacist buys the drugs by the Avoirdupois system and dispenses it by the Apothecary weights.

1 dram/drachm (dr) = 27.344 grains (gr.)
1 ounce (oz) = 16 dr
1 pound (lb) = 16 oz

Table 1 shows the measures of mass (weight) and volume in Avoirdupois system.

<table>
<thead>
<tr>
<th>Measures of Mass (Weight)</th>
<th>Measures of Volume (Fluid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>437.5 gr. = 1 oz</td>
<td>60 minim (min, m) = 1 fluid dram/drachm (fl dr)</td>
</tr>
<tr>
<td>16 oz = 1 lb</td>
<td>8 fl dr = 1 fluid ounce (fl oz)</td>
</tr>
<tr>
<td>14 lb = 1 stone (st)</td>
<td>20 fl oz = 1 pint (pt/o)</td>
</tr>
<tr>
<td>2 st = 1 quarter (qr.)</td>
<td>2 pt/o = 1 quarts (qt)</td>
</tr>
<tr>
<td>4 qr. = 1 hundred weight (cwt)</td>
<td>8 pt/o, or 4 qt = 1 gallon (c)</td>
</tr>
<tr>
<td>20 cwt = 1 ton (T)</td>
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</table>

2. **Troy or Apothecary(ies) System:**

This system of weights and measures is still being used, and should be taken into the consideration. The Apothecary system of weights is a historical system of mass units that was used by physicians and apothecaries for medical, and also sometimes by the scientists. The English version of this system is used in the United Kingdom.

In this system, the weight denominations are expressed as symbols and these symbols are preceded by the numbers (quantity of drug) written in Roman numerals. These numerals will have a line drawn over them and above this line, a dot is placed for each unit numeral to serve as a double check. If the last numeral is a unit, it should be prolonged downwards to indicate that it is the last figure.

This system of weight persisted mainly because the majority of the pharmaceutical balances were supplied with the Apothecary weights. The basic unit of this system is ‘grain’ (gr.). The weight occurs in various sizes from 1/4 gr. to 240 g. This system is used to dispense the prescription and sometimes to compound the medicines. Similar to the Avoirdupois system, this system also has two categories of measurements, weight and volume. Basic unit of weight is grain (gr.) and the basic unit of volume is minim (min, m). Table 2 shows the measures of mass (weight) and volume in Apothecary system.
Table 2: Measures of Mass and Volume in Apothecary (Troy) System

<table>
<thead>
<tr>
<th>Measures of Mass (Weight)</th>
<th>Measures of Volume (Fluid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 scruple = 20 gr.</td>
<td>Measures are same as of the volume (fluid) measures in the</td>
</tr>
<tr>
<td>1 dr = 3 scruples = 60 gr.</td>
<td>Avoirdupois system.</td>
</tr>
<tr>
<td>1 oz = 8 dr = 24 scruples = 480 gr.</td>
<td></td>
</tr>
<tr>
<td>1 lb = 12 oz = 96 dr = 288 scruples = 5760 gr.</td>
<td></td>
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</table>

3. **Metric System (Systeme Internationale, SI)/Decimal System:**

The aim of metrication is to make calculations easier than with the imperial system (ounce, pound, stone, inch, pint, etc.). The SI units are generally accepted in the United Kingdom and many other countries for use in medical practice and pharmacy. This is the official system in most of the countries, including India. Hence, this system has been accepted throughout the world.

The metric system is the official system of weights and measures in the Navy pharmacy departments of India for weighing and calculating pharmaceutical preparations.

The pharmacopoeia recognizes only metric and imperial system.

The weights and volumes are expressed in multiple of ten. The quantities are mostly expressed in terms of smaller units of weight and volume than using decimal points bigger units. The main units to measure the weight, volume and amount of substance are kilogram (kg), litre (L or l) and mole (mol), respectively.

In metric system, the gram (g) is the basic unit of weight, litre (L) is the basic unit of volume and solid to liquid conversion is taken as 1.0 g = 1.0 ml for water and other fluids having specific gravity like water. The measures of mass (weight) and volume in metric system have been mentioned in Table 3. ‘Length’ is measured in millimeter (mm) and centimeter (cm).

**Domestic Measures:**

1 drop = 1 minim (min, m) = 0.06 ml
1 teaspoonful (tsp) = 1 fl dr = 4-5 ml
1 dessertspoonful = 2 fl dr = 8 ml
1 tablespoonful = 4 fl dr = 15-16 ml
1 wine glassful = 2 fl oz = 60 ml
1 teacupful = 4 fl oz = 120 ml
1 tumblerful (glass) = 8 fl oz = 240 ml
1 gallon (c) = 3785 ml

The inter-conversion of the units of weights and volumes from imperial to metric system and vice-versa is shown in Table 4.

### Table 3: Measures of Mass and Volume in Metric (SI) System

<table>
<thead>
<tr>
<th>Measures of Mass (Weight)</th>
<th>Measures of Volume (Fluid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 milligrams (mg) = 1 centigram (cg) = 0.01 g (10^{-2} g)</td>
<td>1 barrel = 35 gallons in UK and 42 gallons in US</td>
</tr>
<tr>
<td>10 decigrams (dg) = 1 gram (g) = 1000 mg</td>
<td>1 gallon (UK) = 4.54 litres (L)</td>
</tr>
<tr>
<td>10 g (10^1 g) = 1 decagram (dag)</td>
<td>1 gallon (US) = 3.785 L</td>
</tr>
<tr>
<td>10 dag = 1 hectogram (hg) = 100 g (10^2 g)</td>
<td>1 L = 1000 millilitres/cubic centimeters (ml/cm^3)</td>
</tr>
<tr>
<td>10 hg = 1 kilogram (kg) = 1000 g (10^3 g)</td>
<td>1 millilitre (ml) = 1000 microlitres (µl)</td>
</tr>
<tr>
<td>100 kg = 1 quintal</td>
<td>1 centilitre (cl) = 0.01 L</td>
</tr>
<tr>
<td>10 quintals = 1 metric ton = 1000 kg</td>
<td>1 decilitre (dl) = 0.10 L</td>
</tr>
<tr>
<td>1 mg = 0.001 g (10^{-3} g) = 1000 micrograms (µg or mcg)</td>
<td>1 decalitre (dal) = 10 L</td>
</tr>
<tr>
<td>1000 nanograms (ng) = 1 µg = 0.001 mg = 10^{-6} g</td>
<td>1 hectolitre (hl) = 100 L</td>
</tr>
<tr>
<td>1000 picograms (pg) = 1 ng = 0.001 µg = 10^{-9} g</td>
<td>1 kilolitre (kl) = 1000 L</td>
</tr>
<tr>
<td>1000 femtograms (fg) = 1 pg = 10^{-12} g</td>
<td></td>
</tr>
<tr>
<td>1000 attograms (ag) = 1 fg = 10^{-15} g</td>
<td></td>
</tr>
<tr>
<td>1 ag = 10^{-18} g</td>
<td></td>
</tr>
<tr>
<td>1 dg = 0.1 g (10^{-1} g)</td>
<td></td>
</tr>
<tr>
<td>1 megagram (mag) = 10^6 g</td>
<td></td>
</tr>
<tr>
<td>1 gigagram (Gg) = 10^9 g</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: Inter-Conversion of Imperial and Metric System Units of Weights and Volumes

<table>
<thead>
<tr>
<th>Weight/Volume in Imperial System</th>
<th>Weight/Volume in Metric System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 grain (gr.)</td>
<td>64.8 milligrams (mg) (approx. 65 mg)</td>
</tr>
<tr>
<td>1 dram/dracm (dr)</td>
<td>3.8879 grams (g) (approx. 4 g)</td>
</tr>
<tr>
<td>1 ounce (oz) (Apothecary system)</td>
<td>31.1035 g (approx. 30 g) or 28 millilitres/cubic centimeters (ml/cm^3)</td>
</tr>
<tr>
<td>1 ounce (oz) (Avoirdupois system)</td>
<td>28.3495 g (approx. 30 g) or 29.37 ml</td>
</tr>
<tr>
<td>8 oz (Avoirdupois system)</td>
<td>237 ml</td>
</tr>
<tr>
<td>1 pound (lb) (Avoirdupois system)</td>
<td>453.59 g (approx. 450 g)</td>
</tr>
<tr>
<td>1 quart (qt) (Avoirdupois system)</td>
<td>946 ml (approx. 950 ml)</td>
</tr>
<tr>
<td>1.06 qt</td>
<td>1 litre (L)</td>
</tr>
<tr>
<td>1/60 gr. = 0.015432 gr.</td>
<td>1 mg</td>
</tr>
<tr>
<td>15.432 gr.</td>
<td>1 g</td>
</tr>
<tr>
<td>2.2046 lb (approx. 2.20 lb)</td>
<td>1 kg</td>
</tr>
<tr>
<td>1 fluid dram (fl dr)</td>
<td>3.5515 ml (approx. 3.5 ml)</td>
</tr>
<tr>
<td>1 fluid ounce (fl oz)</td>
<td>28.4123 ml (approx. 28 ml)</td>
</tr>
<tr>
<td>Measurement</td>
<td>Equivalent (Approx.)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>1 pint (pt/o) (US)</td>
<td>475 ml (approx. 500 ml)</td>
</tr>
<tr>
<td>1 pt/o (UK)</td>
<td>568.2454 ml (approx. 568 ml)</td>
</tr>
<tr>
<td>1.75 pt/o (UK)</td>
<td>1 L</td>
</tr>
<tr>
<td>1 minim (min, m)</td>
<td>0.06 ml</td>
</tr>
<tr>
<td>16.8941 min (approx. 17.00 min)</td>
<td>1 ml</td>
</tr>
<tr>
<td>33.80 fl oz</td>
<td>1 L (approx. 500 g)</td>
</tr>
<tr>
<td>35.196 fl oz (approx. 35.00 fl oz)</td>
<td>1 L</td>
</tr>
</tbody>
</table>
PHARMACEUTICAL CALCULATIONS

OBJECTIVE

To know the different pharmaceutical calculations.

CALCULATIONS

The “calculations” in pharmacy are important from the point of preparing the chemical solutions and calculating the exact amount of drug to be administered to the patient based on the physical condition and body weight of the individual. The calculations are likely to be relatively simple and straightforward, but one needs to be through with the basic mathematical calculations. It is vital; however, one can understand and explain how the final dose is actually arrived at through the calculation.

To prevent the errors in calculations, some of the following preventative measures should be followed while writing the numbers/values in pharmacy/pharmacology:

- Never leave a decimal point naked- Always place a zero (0) before a decimal expression (.) less than one. For example, .25 mg may be read as 25 mg. So, the correct way is: write 0.25 mg, not .25 mg.
- Never place a decimal point and a zero after a whole number- The decimal may not be seen and result in a tenfold overdose. Thus the unnecessary use of decimal points should be avoided. For example, write 5 mg, not 5.0 mg.
- Avoid using decimals whenever whole numbers can be used as alternatives- The quantities less than 1 g should be written in mg. For example, 0.5 g should be expressed as 500 mg. The quantities less than 1 mg should be written in micrograms (µg or mcg). For example, write 500 µg, not 0.5 mg. The quantities of 1 g or more should be expressed as 1.5 g, etc.
- Whenever possible, use the metric system rather than grains or drams (apothecary/avoirdupois).
When decimals are unavoidable, a zero should be written in front of the decimal point where there is no other figure. *For example,* write 0.5 ml, not .5 ml. However, the use of a decimal point is acceptable to express a range, e.g., 0.5-1 g.

Micrograms (mcg) and nanograms (ng) should not be abbreviated. Similarly, the ‘units’ should not be abbreviated.

A capital ‘L’ is used for litre to avoid the confusion (a small letter ‘l’ could be mistaken for a figure ‘1’, i.e., one, especially when typed or printed).

The cubic centimetre (cm$^3$) is not used in medicine or pharmacy; use millilitre (mL or ml), instead of this.

**PER CENT**

The “per cent” (percent, %) means ‘parts of a hundred or a proportion of a hundred’. The symbol for percent is %; so 30%, means 30 parts or units of a hundred. The “percentage” is often used to give a quick indication of a specific quantity, and is very useful when making comparison.

**Percentage and Fraction:**
- To convert a fraction to a percentage, multiply by 100.
- To convert a percentage to a fraction, divide by 100.

**Percentage and Decimal:**
- To convert a decimal to a percentage, multiply by 100- move the decimal point two places to the right.
- To convert a percentage to a decimal, divide by 100- move the decimal point two places to the left.

**PER CENT SOLUTIONS**

The per cent (%) solutions may be of three types:

1. Weight by weight (weight/weight, W/W)
2. Weight by volume (weight/volume, W/V)
3. Volume by volume (volume/volume, V/V)

1. **Weight by Weight:**

In the case of weight/weight (W/W) solution, both the solute and solvent are weight. This represents the number of g of ingredients in 100 g of solution.

2. **Weight by Volume:**

In this case, the solute is weight and the solvent is volume. This represents the number of grams of ingredients in 100 ml of solution. For example, 5% dextrose W/V means 5 g of dextrose by adding enough water to make it dissolved in 100 ml of water.

3. **Volume by Volume:**

In this case, both the solute and solvent are liquid. They are measured in volume. This represents the number of ml of ingredients in 100 ml of solution.

Some per cent solutions of various strengths are shown in Table 5.

<table>
<thead>
<tr>
<th>Strength</th>
<th>Percentage (%)</th>
<th>Quantity (g/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 1</td>
<td>100%</td>
<td>1 g/ml</td>
</tr>
<tr>
<td>1 in 10</td>
<td>10%</td>
<td>10 g/100 ml = 100 mg/ml</td>
</tr>
<tr>
<td>1 in 100</td>
<td>1%</td>
<td>1 g/100 ml = 10 mg/ml</td>
</tr>
<tr>
<td>1 in 1000</td>
<td>0.1%</td>
<td>0.1 g/100 ml = 1 mg/ml</td>
</tr>
<tr>
<td>1 in 10000</td>
<td>0.01%</td>
<td>0.01 g/100 ml = 0.1 mg/ml</td>
</tr>
</tbody>
</table>

**For example:** 5% means 5 g/100 ml = 50 mg/ml; 1% means 1 g/100 ml = 1 mg/ml

### DILUTIONS AND CONCENTRATIONS

A “solution” can be defined as a mixture of two or more substances thoroughly mixed that it becomes physically homogeneous. The dissolved substance is called the ‘solute’ while the substance in which the solute is dispersed is called ‘solvent’. The distilled or clean water is the most popular solvent used, apart from the other commonly employed solvents like alcohol, chloroform, ether, propylene glycol, ethylene glycol, etc. Sometimes, the solvents are also used as ‘vehicles’ and may be complex solutions.
themselves like syrup, elixir, aromatic water and saline solution.

Stock solution can be diluted to make a product which has a lower concentration, and the solution of lower concentration can be made from a given solution by serial dilutions.

**Percentage Concentration:**

- % W/V = number of g in 100 ml (a solid is dissolved in a liquid, thus 5% W/V means 5 g in 100 ml).
- % W/W = number of g in 100 g (a solid mixed with another solid, thus 5% W/W means 5 g in 100 g).
- % V/V = number of ml in 100 ml (a liquid is mixed or diluted with another liquid, thus 5% V/V means 5 ml in 100 ml).

Most common percentage strength encountered is % W/V. There will always be the same amount of drug present in 100 ml, irrespective of total volume. Thus in a 5% W/V solution, there is 5 g dissolved in each 100 ml of fluid, and this will remain same if it is a 500 ml bag or a 1 L bag. To find the total amount of drug present, the total volume must be taken into account— in 500 ml of a 5% W/V solution, there is a total of 25 g present.

**mg/ml Concentration:**

- This concentration is defined as the number of mg of drug per ml of liquid.
- Oral liquids are usually expressed as the number of mg in a standard 5 ml spoonful, e.g., erythromycin 250 mg in 5 ml.
- Injections are usually expressed as the number of mg per volume of the ampoule (1 ml, 2 ml, 5 ml, 10 ml or 20 ml), e.g., gentamicin 80 mg in 2 ml.
- The strengths can also be expressed in mcg/ml.

**Converting Percentage Concentration to mg/ml Concentration:**

- Multiply the percentage by 10, e.g., lidocaine (lignocaine) 0.2% = 2 mg/ml.

**Converting mg/ml Concentration to Percentage Concentration:**

- Divide the mg/ml strength by 10, e.g., lidocaine (lignocaine) 2 mg/ml = 0.2%.
**Parts Per Thousand:**

- This means the parts of the solute dissolved in enough of the solvent to make the solution 1000 ml.

**Parts Per Million (ppm):**

- The ppm means one part of the solute dissolved in one million parts of the solution. So, the ppm is defined as 1 g in 1,000,000 ml or 1 mg in 1 L.
- This is similar to ratio strengths, but used to describe very dilute concentrations. The most common ppm concentration encountered is that of a solid dissolved in a liquid, but can also apply to two solids or liquids mixed together.

**Molar Solution (M):**

- The molarity may be used to measure or compare the concentration of two substances whether gas or particles in the solution.
- The molar solution (M) contains 1 mole or 1 g molecular weight (M.W.) of a solute diluted to 1 L solution. If water of crystallization is included in the formula, it too must be added to the total M.W. For example, to prepare 1 M sodium chloride (NaCl) solution: atomic weight of Na = 22.997; atomic weight of Cl = 35.457; so, M.W. of NaCl = 58.454 g. Hence, 1 M NaCl is one that contains 58.454 g of NaCl in 1 L solution.
- Similarly, a mole (m) is the molecular or atomic weight of a substance in g (m = g / M.W.). For example, the mole of water present in 1 ounce of water = 30 g / 18 M.W. = 1.67 m.
- Similarly, millimoles (mm) = g x 1000 / M.W. = mg / M.W.

**Milliequivalents (mEq):**

- It is the amount of an ionized substance which has the same electrochemical power as one mole of hydrogen ions. A mEq is 1 / 1000, 10^{-3} or 0.001 of an equivalent. It is now common practice to express some of the electrolyte values in terms of mEq/L, instead of mg%. For example, the number of mEq in 100 g of
calcium chloride (CaCl₂, its M.W. = 110.98) will be: mEq = mg x valance / M.W.; mEq = millimoles x valance; then mEq = g x 1000 x valance / M.W. = (100 x 1000 / 110.98) x 1 = 901 mm in 100 g of CaCl₂.

- Similarly, express 321 mg% of Ca⁺ in mEq/L. So, 321 x 10 x 1 / 23 = 140 mEq/L.
- Similarly, express 19.5 mg% of K⁺ in mEq/L. So, 19.5 x 10 x 1 / 19 = 5 mEq/L.

**Isotonic Solution:**

- A solution which possesses the same pressure as that of the fluid of the RBC is considered as “isotonic solution”. It is found that 0.9% W/V solution of NaCl is ‘isotonic’. The solution containing less than that 0.9% NaCl is ‘hypotonic’ and which contains more than that 0.9% NaCl is ‘hypertonic’. The medicated solutions, which are meant for tissues like conjunctiva, nasal mucosa, pharyngeal mucosa, etc. or for intravenous, intraperitoneal, intrauterine or intramammary administration, it is essential to make them isotonic. In such preparations, if the active ingredient provides only certain amount of solute, the particle concentration will be made up by adding a calculated amount of NaCl or other suitable substances. This calculation can be made by the use of NaCl equivalents of different medicaments, by referring to a suitable table. For example, the NaCl equivalent of dextrose is 0.16, which means that 1 g (1%) of dextrose is equivalent to 0.16 g (0.16%) of dextrose. Some other examples of NaCl equivalents are 0.65 for acriflavine and 0.13 for atropine sulphate, etc.

**Unit of Heparin and Insulin:**

- The purity of drugs such as insulin and heparin from animal or biosynthetic sources varies. Therefore, these drugs are expressed in terms of ‘unit’ as a standard measurement rather than weight.

**DENSITY**

“Density” is the mass per unit volume of a substance, e.g., number of g per cubic centimeter (cm³) or ml. It is generally expressed as g/cm³ or g/ml. It may be calculated by
dividing mass/volume.

**SPECIFIC GRAVITY**

“Specific gravity” is the ratio of weight of compound at the weight of an equal volume of water when both substances are added at the same temperature.

For example, the specific gravity of sulphuric acid (H$_2$SO$_4$) is 1.86. So, the weight of 15 ml H$_2$SO$_4$ will be $1.86 \times 15 = 27.9$ g.

**EXERCISE**

1. **Prepare 0.2 mg/ml from 200 mg/ml of a drug solution.**
   
   Calculation:
   
   $0.1$ ml of $200$ mg/ml + $0.9$ ml of distilled water = $20$ mg/ml;
   $0.1$ ml of $20$ mg/ml + $0.9$ ml of distilled water = $2$ mg/ml;
   $0.1$ ml of $2$ mg/ml + $0.9$ ml of distilled water = $0.2$ mg/ml.

2. **Prepare 5 mg/ml from 50 mg/ml of a drug solution.**
   
   Calculation:
   
   $0.1$ ml of $50$ mg/ml + $0.9$ ml of distilled water = $5$ mg/ml.

3. **How 50 ml of 4% dextrose solution is prepared?**
   
   Calculation:
   
   $1$ ml solution contains $= 4$ g of dextrose in $100$ ml of distilled water $(4 / 100)$;
   so, $50$ ml solution will contain $= 4$ g of dextrose in $100$ ml of distilled water x $50$ $(4 \times 50 / 100 = 200 / 100 = 2)$;
   therefore, if $2$ g of dextrose is added, it will make $50$ ml of $4\%$ dextrose solution.

4. **A 20 ml of stock solution of 0.75% is available. Calculate the total amount to which it should be diluted so that the final strength of solution can be 0.15%.**
   
   Calculation:
\[ C_1 V_1 = C_2 V_2 \]

wherein, \( C_1 = 0.75, V_1 = 20 \) and \( C_2 = 0.15; \)
so, \( 0.75 \times 20 = 0.15 \times V_2; \)
so, \( V_2 = 100 \text{ ml}; \)
therefore, the required amount will be \( = V_2 - V_1 \)
\[ = 100 - 20 = 80 \text{ ml}. \]

5. **Prepare 500 ml of 50% alcohol from 95% alcohol solution.**

**Calculation:**
\[ C_1 V_1 = C_2 V_2; \]
wherein, \( C_1 = 50, V_1 = 500 \) and \( C_2 = 95; \)
so, \( 50 \times 500 = 95 \times V_2; \)
so, \( V_2 = 263.15 \text{ ml} \)

6. **How much water should be added to 150 ml of 1:500 W/V stock solution of a chemical to make 1:2000 W/V solutions?**

**Calculation:**
\[ C_1 V_1 = C_2 V_2 \]
wherein, \( C_1 = 1 / 500, V_1 = 150 \) and \( C_2 = 1 / 2000; \)
so, \( 1 / 500 \times 150 = 1 / 1200 \times V_2; \) so, \( V_2 = 600; \)
therefore, the required water will be \( = V_2 - V_1 = 600 - 150 = 450 \text{ ml}. \)

7. **If 500 ml of a 15% solution V/V is diluted to 1500 ml, what will be the % strength?**

**Calculation:**
\[ C_1 V_1 = C_2 V_2 \]
wherein, \( C_1 = 15\%, V_1 = 500 \) and \( V_2 = 1500; \)
so, \( 15 \times 500 = C_2 \times 1500; \)
therefore, \( C_2 = 5\%. \)

8. **Prepare 600 ml of 60% alcohol from 90% alcohol.**
**Calculation:**

Alcohol (90%) or rectified spirit contains 90 parts by volume of ethyl alcohol and 10 parts by volume of water, and hence it is a true (V/V) percentage solution. Let ‘n’ be the number of ml of 90% alcohol as 600 ml of 60% alcohol, i.e.-

\[ \frac{90}{100} \times n = \frac{60 \times 600}{100}; \]

so, ‘n’ = \( \frac{60 \times 600}{90} = 400 \) ml of 90% alcohol is needed to prepare 600 ml of 60% alcohol.
PHARMACEUTICAL PROCESSES

OBJECTIVE

To study the different pharmaceutical processes of drugs.

PHARMACEUTICAL PROCESSES OF DRUGS

Generally, several drugs are not administered in their natural state because they are either too nascent, toxic or present in insignificant amount to be administered directly. Hence, the drugs undergo to certain processes which make them fit for administration. This process is known as “pharmaceutical process”.

Followings are the different pharmaceutical processes of drugs:

A. Processes of Separation:

“Separation” is done to separate the useful ingredients from inert or undesirable particle. If desired material is volatile, then the separation is done by heat. If material is non-volatile, then make use of solvent in which the desirable ingredients are soluble and undesirables are insoluble, e.g., different oils. The separation processes are as under:

1. **Decantation**- This process is the separating of liquid from the solid by gently pouring off the supernatant to get the solid or liquid.

2. **Filtration**- It is the process of separating the liquid from the solid by using a porous substance such as filter paper or sintered glass filter.

3. **Straining or collation**- This is a type of filtration in which the coarser particles are removed from the liquid through fine muslin cloth.

4. **Expression**- It is the process of separating liquid from solid by pressure. The plant juices and oils are obtained by this process.

5. **Clarification**- It is the process of removing a suspended solid material from a liquid without filtration or centrifugation. This is accompanied by either heating
the liquid or changing the pH.

6. **Decolourization or discoloration** - It is the process of removing colouring matter by treating solution of drug with activated charcoal or other absorbent solvents.

7. **Dialysis** - It is the process of separating crystalloid from colloid by means of biological membranes, which allow the passage of water and crystalloids.

8. **Sieving or sifting** - It is the process of passage of drug through a sieve/screen made up of uniform aperture, so that when motion is applied for sometime to the particles smaller than the aperture can pass the screen.

9. **Elutriation** - This is used to separate fine insoluble powder by suspending it in water and decanting.

10. **Crystallization** - It is the process of making crystals of drug.

11. **Centrifugation** - In this, the substance is separated by its difference in movement when it is subjected to centrifugation in a centrifuge. The substance of higher specific gravity moves away from the centre and settles at the bottom of the tube.

**B. Processes of Size Reduction:**

1. **Communition, pulverization, bruising or contusion** - It is the process of reducing a drug by successive blows with the help of mortar and pestle. This is the process to reduce the substance to fine powder by slicing or rasping (grating). ‘Slicing’ is the process of cutting drugs, e.g., slicing of belladonna roots, rhubarb, etc. ‘Rasping or grating’ is the process of reducing substance to small particles with the help of rasp.

2. **Grinding** - It is the process of converting small particles of the drug to fine particles by continuous circular motion in a mortar with a pestle.

3. **Disintegration** - It is the process of grinding by high speed percussion in a disintegrator.

4. **Levigation** - It is the process of grinding of a substance to a very fine powder by grinding it with a small quantity of liquid in which powder is insoluble; e.g., to make ointments, mercuric oxide and zinc oxide are treated by this process.

5. **Trituration** - It is the process of rubbing a substance in a mortar with a pestle in
rotatory motions to reduce the substance in fine particles.

C. *Processes by Heating/Drying:*

1. **Desiccation or drying** - It is the process of removing moisture from the substance at a moderate temperature. It reduces the bulk assist in the preservation. Drying is done in dry and airy place, or in special ovens.

2. **Digestion** - In this, the substance undergoes to prolonged maceration with application of heat. It is used to prepare the tinctures.

3. **Scaling** - By this process, the layers of concentrated solutions of a drug are spread on glass and dried. The dried film is separated and broken up.

4. **Deplumation** - By this, the organic fluid is boiled until the impurities rise to the surface as scum.

5. **Evaporation** - This is the process of removing a solvent from the solution by vaporization in order to concentrate the desired substance. It is used to make extract from decoction, infusion, tincture or other solutions.

6. **Distillation** - This is the process of converting liquid to its vapour state and subsequent condensation of the vapour to liquid. It has two types-
   
   a) **Fractional distillation** - In this, the separation of two volatile liquids with different boiling points occurs.

   b) **Destructive distillation** - It is the process of heating organic substance without exposure to air. The volatile product of decomposition can condense. For example, creosote is obtained from the beech wood tar.

7. **Fusion, liquefaction or melting** - It is the process of converting a solid to liquid by means of heat.

8. **Ignition** - It is the process of strongly heating a substance usually in a crucible without excessive air so as to obtain complete oxidation, resulting in ashes.

9. **Roasting or torrefaction** - By this, sufficient heat is applied to the drug so that some of the constituents are altered without affecting others.

10. **Sterilization and tyndallization** - By sterilization, the bacteria and spores are destroyed. ‘Tyndallization’ is the method of sterilization involving intermittent
heating of preparation at temperature of 100°C. The material to be sterilized is put in sealed container or bottle and heated on a water bath.

11. **Sublimation**- It is the process in which solid is converted into gas and the gas backs to solid, e.g., camphor.

12. **Calcination or incineration**- It is the process in which the drugs are subjected to high temperature so that the watery and volatile substances may be driven off. This is best done by placing the drugs in a crucible over a furnace. For example, the strongly heating carbonate draws out the CO$_2$ and the oxide of metal is left behind, ultimately converting to ashes.

13. **Carbonization**- It is the process of heating or burning the organic substance without the presence of air so that the chemical composition may be changed without oxidation. The aim is to change the chemical combination without oxidation.

**D. Processes in Solution:**

‘Solution’ is a homogenous mixture of two or more substance usually a solid or gas in liquid. The product should be clear. The solutions may be:

i. **Simple solution**- It contains a solute in a solvent without any chemical change or without any saturation.

ii. **Chemical solution**- It is the solution in which the chemical action takes place.

iii. **Unsaturated solution**- In this solution, the solvent contains lesser solute than it can dissolve.

iv. **Saturated solution**- In this, the solvent contains the solute to its full capacity of dissolution.

v. **Super saturated solution**- In this, some means or efforts are made to make a solid to dissolve more of a solute that it could dissolve by the process and heating.

Different processes involved in the solution are as follows:

1. **Maceration**- This is the process of leaving a substance in a solvent, usually alcohol without applying heat to dissolve out the soluble portions. The insoluble residue is called as ‘marc’. ‘Infusion’ is the maceration of drugs. It may be hot
infusion or cold infusion.

2. **Granulation**- In this process, coarsely crystalline salts are converted into granular powder by dissolving in water and evaporating the solution to dryness by continuous stirring, e.g., formation of calcium gluconate.

3. **Percolation**- It is the process of getting the soluble ingredient by the descent of solvent through the substance. It extracts the drug more completely and in shorter time than the maceration. The instrument used in this process is named as ‘percolator’.

4. **Lixiviation**- By this, a soluble salt is separated from a mixed or compound solid by dissolving in water, decanting the supernatant liquid into another vessel and evaporating it to dryness leaving the insoluble behind. The solution is called ‘lye’.
OBJECTIVE

To study the different dosage forms and pharmaceutical preparations.

DRUG DOSAGE FORMS

“Dosage form” of a drug is a product designed and prepared by the pharmacist or a pharmaceutics manufacturer for administration of drug to the patients. On the other hand, a “dosage form” is the physical form of a dose of a chemical compound used as a drug or medication intended for administration or consumption. It is the duty and choice of the doctor to decide the precise dosage form in which the drug is to be administered.

The route of administration of a drug is dependent on the dosage form. Different dosage forms can exist for a single drug, as various medical conditions may warrant different routes of administration. For example, persistent nausea and vomiting (emesis) can make it difficult to use an oral dosage form and in such a case, it may be essential to utilize an alternate route like parenteral, buccal, sublingual, inhalational, nasal or suppository route.

The drugs/drug substances are rarely administered alone, but rather as a part of a formulation in combination with one or more non-medical agents which serve varied and specialized pharmaceutical functions.

The common drug dosage forms are tablet, capsule, pill, syrup, aerosol, inhaler, liquid injection, pure powder or solid crystal (e.g., via oral ingestion or freebase smoking) and natural or herbal form (e.g., plant or food of sorts), etc.

‘Sustained-release (SR) dosage form’ is the dosage form which provides gradual but continued release of drug. The SR dosage forms contain small particles of the drug
coated with materials which require a varying amount of time to dissolve. It provides for a long continued period of absorption and effect. Some particles dissolve and absorb immediately, while others require 2 or 3 hours.

**AIMS OF DRUG DOSAGE FORMS**

The chief goals/aims of using different dosage forms are:

1) Mask the taste of offensive drugs.
2) Mechanism for the safe and convenient delivery of accurate dosage.
3) Protection from the influence of gastric acid after oral administration.
4) Protection of a drug substance from the destructive influences of atmospheric humidity or oxygen.

**DIFFERENT DRUG DOSAGE FORMS/PHARMACEUTICAL PREPARATIONS**

Different dosage forms are administered by different routes of administration. Therefore, the pharmaceutical preparations (formulations) can be classified as under:

**A. Depending on Route of Administration or Nature of Drugs:**

1. **Oral drug dosage form-**
   a. **Solid-** e.g., tablet, capsule, powder, pill, etc.
   b. **Liquid-** e.g., mixture, emulsion, tincture, syrup, elixir, aqua, etc.

2. **External drug dosage form-**
   a. **Liquid-** e.g., drop, lotion, liniment, paint, tincture, etc.
   b. **Solid-** e.g., suppository, cream, ointment, plaster, gel, etc.
   c. **Gas/vapour-** e.g., aerosol, spray, etc.

3. **Parenteral drug dosage form-**
   a. **Liquid-** e.g., serum, etc.
   b. **Solid-** e.g., pellet, etc.

**B. Drug Dosage Forms Based on Physical Characters of Drugs:**

1. Solid form- e.g., powder, capsule, tablet, pill, bolus, etc.
2. Semisolid form- e.g., ointment, paste, emulsion, etc.

3. Liquid form- e.g., aromatic water, tincture, lotion, solution, mixture, etc.

1. **Solid drug dosage forms**-
   a) **Powder (Pulvis)**- It is the mixture of two or more than two powdered substances intended for external/internal use. It may be prepared by mixing the ingredients; e.g., boric acid powder (simple) and bismuth carb powder (compound).

   b) **Capsule**- This is prepared by enclosing medicaments in a suitable envelop made of gelatin. The capsules are either flexible or hard. They are small ovoid or cylindrical soluble containers intended to be filled with a drug and swallowed. They are usually prepared to hold nauseant, volatile or irritating drugs and are meant for oral administration. The keratin capsules are not soluble in gastric juice.

   c) **Spansule (Repetab)**- This is delayed action capsule which occurs due to coating the particles of active ingredients with an agent that provides intermittent release of the drug in the gastrointestinal tract (GIT). That is, this is prepared by charging with drug pellet of varying size, the smallest disintegrating first and the largest last. It affords all day and all night therapeutic effect with a single oral dose.

   d) **Tablet (Tabella)**- This is a circular, biconvex or flat solid discoid dosage form, or of varying size, shape and weight containing granulated or powdered drug that is compressed or molded into round or discoid shape with the help of machine. The tablet contains drug + vehicle + binder. So, the tablet contains drug(s) in pure or diluted form; e.g., paracetamol tablet (500 mg), ampicillin tablet (250 mg), etc. The tablets are of the following types-

   i. **Enteric coated tablets**- Both tablets and capsules can be enteric coated to protect the drug from effect of gastric secretions, and to prevent drug irritation of gastric mucosa; e.g., the enteric coated tablets are coated with phenyl salicylate or salol. They are insoluble in acid but soluble in alkaline media.

   ii. **Scored tablets**- These are the tablets with clear indication in the centre showing two equal halves.

   Similar to pills, the tablets are also coated with different substances. They may be
made with or without a diluents (dextrose, lactose, starch, etc.), and may differ greatly in size, weight and shape. The types of tablet may be normal, effervescent, chewable, delayed release, film coated or sugar coated tablet. The hypodermic tablets are used for preparation of solution for hypodermic injections; e.g., aspirin tablet, barbitone tablet, etc. The compressed tablets are made with heavy machinery. In addition to the drug, the compressed tablets generally contain:

(i) **Excipient**- the inner material included when the volume of the active drug is too low to provide a tablet of convenient size.

(ii) **Diluent**- used when the amount of active ingredient is small.

(iii) **Binder**- the substance which gives adhesiveness to the powdered drug.

(iv) **Disintegrator**- e.g., starch helps the tablet to dissolve readily when it is placed in water, because the starch expands when it gets wet.

(v) **Lubricant**- keeps the tablet from sticking to the machines.

Tablets are sometimes scored (marked with an intended line across the surface), so that they can be broken easily if half a tablet is the dose required. The tablets may be coated with sugar or chocolate to enhance their palatability. They can be covered with a coloured coating to make them more attractive to patients, easier to swallow, or identifiable by the use of distinctive colours.

e) **Pellet**- This is the small sterile sphere formed by the compression of certain insoluble crystalline steroid hormones for subcutaneous implantation.

f) **Pill**- When the powdered drugs are mixed with some sticky substances and may be molded into spherical, globular, oval or flattened solid bodies, they are called ‘pills’. Usually, the pill is sugar coated intended to be swallowed without chewing. The pills are prepared by mixing the ingredients with a basis like soap, gum, liquid glucose, etc. Sometimes, the pills are coated with various substances, viz., varnish coating, silver leaf coating, sugar coating, gelatin coating, pearl coating, enteric coating, keratin coating, etc.; e.g., oral contraceptive pills. The pills have been replaced to a great extent by capsules and tablets.

g) **Bolus**- It can be defined as a large pill. It is a pill, more or less a semisolid preparation in which the medicaments are incorporated with the help of an
excellent and is of variable size. This is a cylindrical or biconical mass, and contains one or more medicinal ingredients uniformly distributed throughout the mass. To mask the taste of certain drugs, the bolus may be coated with gelatin or other suitable materials which protect the bolus from deterioration during storage. The vehicles used for bolus may be adhesive materials such as gum acacia, treacle, starch, sugar syrup, soft soap, linseed meal, etc. A bolus weighs about 2 ounces. It is about 2½ inches long and ½ inch in diameter, and is slightly tapered. The bolus is safely administered to the large animal with the help of a ‘balling gun’ of suitable size. The bolus is placed at the back of the tongue so that the animal is obliged to swallow it. The advantage is that the accurate dosage can be given without the loss of any medicament. Its use is restricted in veterinary medicine, especially in ruminants; e.g., bolus of aloe, oxytetracycline (500 mg or 1 g) bolus, sulphadimidine (5 g) bolus, etc.

h) **Suppository**- This is a soft conical or ovoid mass, containing active ingredients in a suitable base intended for insertion into the rectum or vagina where it melts. The melting temperature is slightly below the body temperature. The suppositories are dissolved, or they disperse and exert their local or systemic effect. They are solid at room temperature but liquid at body temperature. Most of them contain oil of theobroma as the basis, and few may contain glycerine; e.g., nutrient suppository, tannic acid suppository, etc. The suppositories are of two types-

i. **Prepuseal suppositories**- e.g., bull cones.

ii. **Rectal/anal suppositories**- These are inserted into the rectum. They are used in small animals for local effect.

i) **Bougy**- It is a rod shaped solid dosage form for administration of medicament into the teat canal, udder, nostril, urethra, ear, etc.

j) **Pessary**- It is a solid medicated preparation for introducing medicaments into the uterus and vagina. The pessaries contain antiseptic agents. They are usually bluntly conical in shape, and are used for local action. Nowadays, they are prepared in big tablets (intrauterine tablets); e.g., boric acid pessary, acriflavine pessary, etc.
2. **Semisolid drug dosage forms**

   a) **Ointment (Unguenta)**- It is a semisolid soft preparation in fatty, oily or paraffin bases, used for external application. Therefore, an ointment is a homogeneous, viscous, semisolid preparation, most commonly a greasy, thick oily (oil 80% and water 20%) with a high viscosity, that is intended for external application to the skin or mucous membranes. The animal fats (lard, suet, tallow) and animal waxes (wool fat) are used as absorption base, while the paraffin is used as protective base. The ointments are used as emollients, or for the application of active ingredients to the skin for protective, therapeutic or prophylactic purposes and where a degree of occlusion is desired. They are applied to the skin with or without friction. The examples are: ointment of sulphur, ointment of zinc oxide, ointment of yellow oxide of mercury, ointment of glycerine, etc. Eye ointments are called ‘oculentum’. The ‘oculentum’ is prepared aseptically and available in small sterilized collapsible tubes; e.g., ointment of penicillin, ointment of sulphacetamide, fusidic acid ointment, clindamycin phosphate ointment, boric acid ointment, sulphur ointment, etc.

   b) **Paste**- It is a medicinal preparation intended for external application. It usually contains high proportion of powder mixed with the soft (or liquid) paraffin or starch, or with known greasy base made with gelatin, glycerine, mucilage or soap; for example, paste of iodoform, paste of bismuth subnitrate, paste of magnesium sulphate, arsenic paste, etc.

   c) **Poultice (Cataplasma)**- This is a soft pasty preparation applied hot or cold for local application of heat and moisture with the object of reducing the inflammation and to relieve the pain.

   d) **Plaster (Emplastrum)**- It consists of medicinal substances mixed with the adhesive substance and spread onto cloth or canvas for application to the skin, where at body temperature it melts slightly and becomes adhesive. That is to say, the plasters are solid, adhesive preparations, spread on some fabric, and generally requiring warming before being applied to the body. The plasters act as protectant and their counterirritant effect bring two edges of wound together; for example,
plaster of belladonna (green belladonna plaster), plaster of cantheridine, plaster of capsicum, etc.

e) **Electuary (Electarium)**- This is a soft medicinal paste intended to be smeared on the tongue and lips. The sugar, honey and treacle are used as vehicle. The electuaries are mostly used in cattle and horses.

### 3. Liquid drug dosage forms-

**a) Aromatic water (Aqua)**- This is the solution of volatile substances in water and this solution has the odour of oils; e.g., aqua cinnamoni, aqua camphorae, aqua chloroformae, etc.

**b) Syrup**- This is nearly saturated solution of sucrose or refined sugar in water. Mostly, all syrups contain a flavouring agent and a medicinal agent; e.g., syrup of codeine phosphate, syrup of acacia, syrup of lactic acid, etc.

**c) Elixir (Elixirum)**- This is the tincture containing sugar and aromatic substances; e.g., paregoric elixir, cascara sagradae, elixir of anise, elixir of cinchona, etc.

**d) Liquor (Solution)**- This is the solution of non-volatile substances in water. Alcohol, oil and other solutions are also used in few cases. For example, liquor ammonia aromaticus, liquor adrenaline hydrochloride, solution of acriflavine, alkaline solution, etc.

**e) Lotion**- This is the solution/suspension of drugs generally in water intended for external use to wash the affected parts. Sometimes, alcohol and glycerine are also added. They are applied to the skin without rubbing. They are also used for aural, nasal, ophthalmic or urethral irrigation; e.g., lotion of calamine, lotion of salicylic acid, lotion of tannic acid, lotion of boric acid, etc.

**f) Mixture (Mistura)**- This is the preparation in which one or more drugs are dissolved or suspended in a fluid medium (usually water) for internal use. It contains more than one dose; e.g., mistura alba (white mixture), mixture of chalk, mixture of catechu, etc.

**g) Emulsion**- This is the suspension of oily or resinous substances or insoluble powders or liquid substances by means of adhesive substances known as
emulsifier or emulgent’; e.g., emulsions of chloroform, castor oil and cod liver oil, etc.

h) Decoction (Decotum)- It is obtained by boiling the drug in water. Usually, boiling is done for 15 minutes and the strength is 5%; e.g., decoction of barley.

i) Infusion- It is obtained by steeping the drug in cold water. The infusion should not be boiled in which it differs from a decoction. It must be freshly prepared and should be used within 12 hours; e.g., concentrated infusion of chirata, etc.

j) Spirit (Spirityus)- This is the alcoholic solution (90% alcohol) of drugs, especially volatile drugs; e.g., spirit of chloroform, spirit of camphor, spirit of ammonia, spirit of anise, etc.

k) Tincture (Tincturum)- This is the alcoholic solution of non-volatile drug(s), made by extraction of the important medicinal principles of vegetable drug(s). The tinctures may be simple (when only one ingredient is used in alcohol), or compound (when more than one ingredients are used in alcohol by process of maceration or by percolation); e.g., tincture of iodine, tincture of belladona, tincture of opium, tincture of nux-vomica, tincture of ginger, etc.

l) Extract- This is the preparation containing the active principle of crude drugs. Thus, it is either solid or semisolid or liquid preparation of active constituents of drugs prepared by extracting the drug with the proper menstrum and evaporation of the percolate and adjusting the remaining mass or power to the prescribed standard. Various types of extracts are liquid extract, solid extract, soft extract and dry extract; e.g., liquid extract of orange, extract of ergot, extract of Cannabis, extract of Strophanthus.

m) Liniment (Embrocation)- This is the liquid or semiliquid preparation in oil, alcohol, acetone or similar quickly evaporating solvent or soap solution, intended for external use only. The liniment (also called as ‘balm’) is the pharmaceutical topical preparation, typically sold to relieve the pain and stiffness; e.g., from sore muscles or from arthritis. The liniments contain counter-irritant aromatic chemical compounds like methyl salicilate, benzoin resin or capsaicin. These are rubbed on intact skin with friction. Camphor is present in all official liniments which
increases the local action. Examples of liniments are opodeldoc, absorbine, turpentine oil liniment, liniment of methyl salicylate, liniment of ammonia, liniment of opium, etc.

n) Injection- This is the sterile or aqueous solution/suspension of drug prepared for parenteral administration. In some cases, it is used through the external orifices of the body; e.g., injection of digitalis, etc.

OTHER PHARMACEUTICAL FORMULATIONS/PREPARATIONS

There are some other pharmaceutical formulations/preparations, as described below:

1. **Vinegar (Acetum)**- This is a solution of drug(s) in acetic acid, prepared by dissolving the active principle in acetic acid, or macerating the drug itself in acetic acid; e.g., vinegar of ipecacuana, vinegar of squill, etc.

2. **Aerosol**- This is a preparation of liquid or micro-pulverized powders administered by a spray or nebulizer. The aerosol is a nasal spray which creates an aerosol mist of liquid particles. The inhalation aerosols are intended for respiratory passages; e.g., flixonase (fluticasone propionate), etc.

3. **Ampoule (Ampulla)**- This is a hermetically sealed container filled with sterile material generally intended for sc, im or iv injection.

4. **Bath**- This is the immersion of the whole body or part of the body in some liquid or vapour; e.g., mustard bath, iodine bath, etc.

5. **Gauze**- This is the cotton cloth of plain weave steeped in antiseptic solutions and dried; e.g., boric acid gauze, iodoform gauze, etc.

6. **Nasal wash (Collunarium)**- This is for washing of noses; e.g., alkaline nasal wash, compound solution of borax, etc.

7. **Mouth wash (Collutorium)**- It generally consists of solution of mild antiseptic or astringent agents.

8. **Eye lotion (Collyrium)**- It is the solution in water of one or more substances intended for application to eye; e.g., boric acid eye lotion, borax eye lotion, etc.

9. **Enema (Enematum)**- It is the liquid preparation meant for injection into the rectum by means of a suitable instrument. For example, anathematic enema,
astringent enema, purgative enema, antispasmodic enema, emollient enema, sedative enema, nutrient enema, etc.

10. **Fomentation (Fomentum)**- It consists of flannel cloth or sponges wrung out of hot water in which drugs may or may not have been added. This is for application to the surface of body and employed to relax and soothe the inflamed parts.

11. **Gargle**- This is liquid preparation used for topical application on mouth, throat and pharynx; e.g., tannic acid gargle, potassium permanganate gargle, etc.

12. **Drop (Gutta)**- It is a liquid preparation of the drug(s) and used as eye drops; e.g., cocaine eye drop, pilocarpine eye drop, etc.

13. **Draught (Haustus)**- It is a liquid preparation for administration by the mouth consisting of a single dose.

14. **Insufflation**- This is the powder prepared for introduction into the ear, nose or throat. It is administered by means of insufflators, or where intended for the nose they may be used in the same way as ordinary snuff; e.g., adrenaline insufflations, menthol insufflations, etc.

15. **Jujube**- It is the lozenge made of gum acacia and sugar.

16. **Lamella**- This is the gelatin disc softened with glycerine and impregnated with drug(s) acting on the eye. It is placed under the eyelids or conjunctival sac; e.g., lamella of atropine, lamella of cocaine, etc.

17. **Linctus**- This is a thin part, containing drugs to be licked up and slowly swallowed in small doses so as to act on the throat; e.g., linctus of codeine, linctus of squill, etc.

18. **Honey (Mellitum)**- This is a thick liquid preparation containing medicinal agents blended with honey; e.g., honey of borax.

19. **Mucilage**- This preparation contains gum in suspension or solution; e.g., mucilage of gum acacia, etc.

20. **Spray (Nebula)**- This is the solution of drug(s) in aqueous, oily, alcoholic or glycerinated medium to be sprayed into the nose or throat with the help of a spray producer, nebulizer; e.g., adrenaline and cocaine spray, adrenaline and ephedrine spray, etc.
21. **Eye ointment (Oculent)**- It is the preparation containing drug(s) with sterile base consisting of specified proportion of soft and hand paraffin and lanolin intended for application to the eye; e.g., boric acid eye ointment, etc.

22. **Oil (Oleum)**- Many types of oil are used in the preparations of drug(s); e.g., lubricant oil, carbolized oil, etc.

23. **Pastille**- It is the soft medicinal preparation which has glycerine, gelatin or gum acacia sugar as its base. It is used like lozenge; e.g., menthol pastille, *Eucalyptus* pastille, etc.

24. **Pearl**- It is a minute pill or capsule.

25. **Paint**- This is a liquid preparation of medicinal agent intended for application to the throat, skin and other parts; e.g., compound aconite, chrysarobin paint, Mandl’s paint, etc.

26. **Lozenge (Troch)**- This is a flat, round or rectangular preparation (hard circular or oval disc like mass) which is held in the mouth until it dissolves, liberating the drug(s) involved. The lozenges or troches usually contain water, sugar and mucilage in addition to the drug, and are dried in hot air. They temporarily produce a high concentration of drug in the oral cavity. They are held in the mouth until entirely dissolved; e.g., benzoic acid lozenge, dextromethorphan lozenge, strepsil lozenge, etc.

27. **Inhalation (Vapour)**- This is the preparation, containing one or more volatile ingredients which when inhaled in a suitable manner, is intended to act on the throat, lung and nasal passage; e.g., compound cresol inhalation, compound *Eucalyptus* inhalation, etc.

28. **Demulcent**- This is used for its action in coating the inflamed mucous surface, thereby protecting from irritation.

29. **Emollient**- This is a bland substance applied to the skin; e.g., adepts, lance, petrolatum, glyceritum, etc.

30. **Counterirritant**- It inflames the skin and acts reflexly by heightening sensibility in that region of the cord receiving the sensory fibers irritated, and thereby affecting the condition of all parts supplied by such nerves as have synapses in
that same region of the cord.

31. Astringent- Vegetables astringents are used to be largely employed for checking the diarrhoea, but the modern treatment aims at the cause. Thus, the use of these astringents has normally been abandoned. Mineral astringents are employed for their effect in coagulating albumins; e.g., cupri sulphas, argenti nitras, alume, etc.

32. Protective- It is a substance which, by coating a surface with a relatively permanent and insoluble pellicle, excludes air, water and other irritating materials; e.g., zinci stearas, tincture benzoini, collodium, etc.

33. Cerate (Ceratum)- It is unctuous fatty preparation, similar to the ointment, but has higher melting point and not liquefying at the body temperature.

34. Cream (Cremorum)- It is a soft similitude preparation for external use without friction. On the other hand, the cream is a topical preparation, usually for application on the skin. The creams are semisolid emulsions, having the mixture of oil and water; e.g., cold cream, fluocinolone acetonide cream, zinc cream, etc. The creams are of two types:
   i. Oil-in-water (O/W) creams- They are composed of small droplets of oil dispersed in a continuous water phase.
   ii. Water-in-oil (W/O) creams- They are composed of small droplets of water dispersed in a continuous oily phase.

35. Gel (Balm)- It is defined as a substantially dilute cross-linked system, which exhibits no flow when in the steady state. By weight, the gels are mostly liquid, yet they behave like solids due to a three-dimensional cross-linked network within the liquid. The crosslinks within the fluid give a gel structure (hardness) and contribute to the stickiness (tack). In this way, the gel share a dispersion of molecules or particles within a liquid in which the solid is the discontinuous phase and the liquid is the continuous phase. Examples of gels are androfil gel, chlorben gel (benzocaine), etc.

36. Otic solution (Ear drop)- This is a form of medicine used to treat or prevent the ear infections, especially infections of the outer ear canal (otitis externa). Examples are ciprodex ear drop (ciprofloxacin and dexamethasone), sofradex ear
drop (framycetin sulphate, gramicidin and dexamethasone), etc.

37. **Ophthalmic solution (Eye drop)**- This is saline-containing drop used as a route to administer medication in the eye; e.g., betnesol (betamethasone sodium phosphate), etc.

38. **Transdermal preparation (Skin patch)**- This is intended for slow release of the drugs; e.g., oestradiol, etc.

39. **Inhaler**- An inhaler or puffer is a nasal spray as a medical device used for delivering medication into the body via the lungs. It is mainly used for the treatment of asthma and chronic obstructive pulmonary disease (COPD). Examples are ventolin (fluticasone propionate), zanamivir (relenza), etc.
OBJECTIVE
To study the different routes of drug administration.

DIFFERENT ROUTES OF DRUG ADMINISTRATION

There are different routes by which a drug can be administered to a person or animal. Depending upon the preparations and forms of drug, a particular route should be chosen. Different routes for the administration of drug are as under:

1. **Oral Route:**
   By “oral route”, drug is given through the mouth. Solid or liquid form of medicine can be given by this route. Liquid form of medicine can be given as drench, using drenching bottle or bamboo made drenching bottle in the rural areas where there is bamboo. While drenching an animal, care has to be taken to prevent accidental drenching into the lungs. Other way of giving medicine by this route is mixing the medicine with feed. It is better to take a small amount of feed, mix the medicine and then give it to animal before giving the rest of feed to ensure that animal consumes the medicine.

2. **Local or Topical Route:**
The “local/topical route” means applying the medicine/drug on the surface of affected part. This is also called ‘local application’; e.g., applying an ointment on the skin wound. Cream, gel (balm), liniment, tincture, oil, otic solution (ear drop), etc. are also applied locally.

3. **Parenteral Route:**
This is the administration of drug with the help of a syringe and a hypodermic
needle. There are many “parenteral routes” as given under:

a) Subcutaneous (sc)- This is the deposition of medicine beneath the skin. Usually, it is done at the neck region where there is loose skin. In small animals like dog and cat, sc route is given at the flank region. This route is mainly used for the deposition of vaccine, which requires slow absorption into the circulation.

b) Intramuscular (im)- This is the deposition of medicine deep into the muscle of animal body. For giving im injection, a region with thick muscle is to be selected.

c) Intravenous (iv)- This is the deposition of medicine directly into the blood circulation through the superficial veins. This route can be used when quick action is desired, and also when a large volume of preparations like dextrose or normal saline is required, or for the blood transfusion.

d) Epidural- This is the deposition of preparation, such as local anaesthetics into the spinal cord to desensitize the nerves supplying the hindquarters.

e) Intraperitoneal (ip)- This is the deposition of preparation into the peritoneal cavity. This is done when the fluid therapy can not be done through the iv route due to severe dehydration.

f) Intrarumenal (ir)- This is the deposition of medicine or preparation into the rumen by rumen puncture.

4. Other Routes:

a) Intravaginal- This is the placing of medicine into the vagina.

b) Intrauterine (iu)- This is the deposition of medicine into the uterus.

c) Ocular- This is the placing of drug (ophthalmic solution or eye drop) into the eye.

d) Intraarticular (ia)- This is the deposition of medicine into the joint cavity.

e) Per rectal- This is the deposition of medicine into the rectum.

f) Nasal route (Intranasal or inhalation)- This is the administration of medicine in the form of vapour through nose; e.g., aerosol and inhaler are applied through the nasal route.

g) Intramammary- This is the deposition of medicine into the mammary gland.
ADVANTAGES AND DISADVANTAGES OF DIFFERENT ROUTES

The advantages and disadvantages of different routes of drug administration have been described in Table 6.

### Table 6: Advantages and Disadvantages of Different Routes of Drug Administration

<table>
<thead>
<tr>
<th>Route</th>
<th>Drug Preparation</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>Liquid (solution, suspension, emulsion, syrup), semisolid (paste), solid (tablet, capsule, powder, granule, premix, medicated block), device (balling gun), etc.</td>
<td>Easy, convenient, acceptable, painless for human and monogastrics to some extent</td>
<td>Inappropriate during vomiting, potential drug-stability problem, interaction with food, possible low availability; patient must be conscious</td>
</tr>
<tr>
<td>Buccal</td>
<td>Tablet, mouth wash, etc.</td>
<td>Rapid onset of action, dosage form recoverable, no first-pass metabolism</td>
<td>Only suitable for low dose (high potency) drugs</td>
</tr>
<tr>
<td>Tracheobronchial surface, alveolus</td>
<td>Inhalational anaesthetic, aerosol (including vaccine), etc.</td>
<td>Covers larger surface area</td>
<td>Trained person and exact dosage needed</td>
</tr>
<tr>
<td>Topical- skin, mucus membranes, ocular, aural, etc.</td>
<td>Dip, spot-on, spray, patch, insecticidal collar, ointment, cream, ear drop, eye drop, insert, hydrogel (localized delivery of antimicrobial drug)</td>
<td>Avoids systemic and adverse effects on body</td>
<td>Majority of drugs have only local effect</td>
</tr>
<tr>
<td>Parental- iv, im, sc, ip, ia, iu, ir, intraarterial, etc.</td>
<td>Solution, intraarticular implant, depot preparation (excipient, stabilising agent, buffer, chelating agent, surfactant, pyrogen-free suspension, emulsion, implant, lyophilized powder fro reconstitution), etc.</td>
<td>Gives exact dose, 100% compliance, suitable for unconscious patient, rapid onset</td>
<td>Painful, self-administration can be done, expensive production process, requires trained personnel</td>
</tr>
<tr>
<td>Intramammary, Intravaginal, Intrauterine</td>
<td>Intramammary infusion, implant (hormone), sponge, pessary, applicator, etc.</td>
<td>Mainly for infection/inflammation of local organs</td>
<td>Requires utmost sterility and proper method</td>
</tr>
<tr>
<td>Rectal</td>
<td>Suppository, enema (solution, suspension, emulsion), foam, ointment, cream, etc.</td>
<td>Avoids stability problem in GIT, no first-pass metabolism, useful if oral route is not possible</td>
<td>Unpopular, inconvenient, erratic absorption, irritation</td>
</tr>
</tbody>
</table>
OBJECTIVE

To know the writing of prescription.

DEFINITION OF PRESCRIPTION

“Prescription” is a written order of a practitioner to the pharmacist containing the names and quantity of drugs, the manner of compounding and dispensing, and the methods of administering the medicines with instruction regarding the diet and other particulars.

PARTS OF PRESCRIPTION

The prescription is comprised of the following parts:

1. Name and address of prescriber
2. The Description of the patient
3. The superscription
4. The inscription-
   a. Simple
   b. Complex-
      i. The basis;
      ii. The adjuvant;
      iii. The coregent or the corrective;
      iv. The vehicle/the excipient/the menu strum.
4. The subscription
5. The signature
6. The prescriber’s initial and name with date
1. **Name and Address of Prescriber:**

   The name and address of the prescriber should be written on every prescription. Date of writing the prescription should be mentioned to know the doses and at what interval drug to be given. Duration of the treatment tells about the nature of the prescription written for a disease or a stage of the disease.

2. **The Description of the Patient:**

   The patient’s description includes the address and name of the owner, and description of the animal. Age and weight of the patient is very essential. Breed should be mentioned for small animals.

3. **The Superscription:**

   It consists of the symbol ‘Rx’ (or Rj). This R is derived from the Latin word ‘recipe’, meaning ‘take thou of’. The oblique (j) line across the ‘R’ is the symbol which denotes the invocation of doctor/veterinarian to ‘Roman god Jupiter’ (the god of healing) who is considered as the god of healing, asking him to help in making the prescription effective for the cure of disease. Thus, this ‘j’ stands for the ‘Jupiter or jou’.

4. **The Inscription:**

   It is the main body of the prescription which contains the name of the drug in full and their quantities. The name of each drug should be written one below the next with first letter in capital. The inscription can be simple or complex.
   
   a. **Simple prescription** - In this, there is one drug and a vehicle, if any.
   
   b. **Complex prescription** - In this, the followings are written-
      
      i. *The basis* - It is the main drug with which it is hoped to cure the disease.
      
      ii. *The adjuvant* - It is the drug which assists or enhances the action of the basis and it is generally synergistic to the basis.
      
      iii. *The coregent/the corrective* - It is the drug which removes the undesirable effect of the basis and the adjuvant.
      
      iv. *The vehicle/the excipient/the menu strum* - It is an inert agent which converts
the drug to a form suitable for administration. The vehicle performs the following functions-
• It increases the bulk to facilitate the administration of the drug.
• It dilutes the active ingredient.
• It acts as the solvent for soluble drugs.
• It gives shape and proper consistency to the preparation.
• It adds good taste and flavour to the drug.
• It may reduce the bad odour of the drug.

5. The Subscription:
It consists of directions given by the prescriber to the pharmacist for compounding and dispensing the drugs in suitable dosage form. This is written in ‘Latin’; however, it can be written in English also.

6. The Signatura/Instruction to the Patient:
The word ‘signatura’ is derived from the Latin word ‘signa’ or ‘S’, meaning ‘write/let it be labeled’. It contains the direction to the patient/patient’s owner or the attendant regarding the manner of administration of medicine, indicating the specific dose, method and time of administration of drug. This part is written in English or local language. The pharmacist must write the instructions on the “label” before dispensing it.

7. The Prescriber’s Name with the Signature/Initial and Date:
This is done to make the prescription a legal document. Here, the registration number of the physician/doctor can also be written.

LATIN ABBREVIATIONS USED IN PRESCRIPTION
“Abbreviations” are used for instructions given for compounding, dispensing and administration of drugs. Abbreviations of ‘Latin’ words are commonly used in writing, the prescription due to following advantages:

a. ‘Latin’ is universally understood, dead language and not likely to change with
time and place.

b. ‘Latin’ maintains certain degree of professional secrecy, which prevents attempts of self doctoring.

c. It saves time.

d. It is readily understood by the pharmacist.

The names of drugs in the prescription should be written in full to avoid the possible errors, if written by abbreviations. The chemical formulas should not be written in the prescription because of the greatly increased probability of error.

Commonly used ‘Latin abbreviations’ in prescription writing are as under (Table 7):

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Latin Word</th>
<th>English Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, aa, a.a.</td>
<td>Ana, ana</td>
<td>of each</td>
</tr>
<tr>
<td>a.</td>
<td>ante</td>
<td>before</td>
</tr>
<tr>
<td>a.c.</td>
<td>ante cibum</td>
<td>before meals</td>
</tr>
<tr>
<td>ad</td>
<td>Ad, ad</td>
<td>to, up to</td>
</tr>
<tr>
<td>Ad lib, ad.</td>
<td>Ad libitum, ad libitum</td>
<td>freely as wanted, at pleasure</td>
</tr>
<tr>
<td>alt</td>
<td>alter</td>
<td>the other</td>
</tr>
<tr>
<td>alt. hor</td>
<td>alternis horis</td>
<td>every other hour</td>
</tr>
<tr>
<td>Aq, aq.</td>
<td>Aqua</td>
<td>water</td>
</tr>
<tr>
<td>b</td>
<td>bis</td>
<td>twice</td>
</tr>
<tr>
<td>b.i.d., b.d.</td>
<td>bis in die</td>
<td>twice a day</td>
</tr>
<tr>
<td>c, c.</td>
<td>Cum, cum</td>
<td>with</td>
</tr>
<tr>
<td>cap</td>
<td>capula</td>
<td>capsule</td>
</tr>
<tr>
<td>cib</td>
<td>cibus</td>
<td>food</td>
</tr>
<tr>
<td>Collyr.</td>
<td>Collyrium</td>
<td>eye lotion</td>
</tr>
<tr>
<td>cum aq.</td>
<td>cum aqua</td>
<td>with water</td>
</tr>
<tr>
<td>dim</td>
<td>dimidus</td>
<td>one half</td>
</tr>
<tr>
<td>disp.</td>
<td>Dispensa</td>
<td>dispense</td>
</tr>
<tr>
<td>div.</td>
<td>divide</td>
<td>divide</td>
</tr>
<tr>
<td>dos</td>
<td>dosis</td>
<td>a dose</td>
</tr>
<tr>
<td>d.t.d.</td>
<td>denture tales doses</td>
<td>give such doses</td>
</tr>
<tr>
<td>e lact</td>
<td>e lacte</td>
<td>with milk</td>
</tr>
<tr>
<td>Elect, elect</td>
<td>electuarium</td>
<td>electuary</td>
</tr>
<tr>
<td>emul</td>
<td>emulsio</td>
<td>emulsion</td>
</tr>
<tr>
<td>eq.pts</td>
<td>equalis partis</td>
<td>equal parts</td>
</tr>
<tr>
<td>et</td>
<td>Et, et</td>
<td>and</td>
</tr>
<tr>
<td>ex.aq</td>
<td>e.aqua</td>
<td>with water</td>
</tr>
<tr>
<td>flavum</td>
<td>flavum</td>
<td>yellow</td>
</tr>
<tr>
<td>fortis</td>
<td>fortis</td>
<td>strong</td>
</tr>
<tr>
<td>Ft, ft.</td>
<td>fiat</td>
<td>make, let it be made</td>
</tr>
<tr>
<td>gtt, gtt.</td>
<td>gutta, guttae</td>
<td>drop, drops</td>
</tr>
<tr>
<td>h</td>
<td>hora</td>
<td>hour</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------------</td>
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<td>---------</td>
</tr>
<tr>
<td>h.s.</td>
<td>hora somni</td>
<td>at bed time</td>
</tr>
<tr>
<td>haust.</td>
<td>Haustus</td>
<td>drench</td>
</tr>
<tr>
<td>ind</td>
<td>in dies</td>
<td>daily</td>
</tr>
<tr>
<td>Inj, inj</td>
<td>injectio</td>
<td>injection, an injection</td>
</tr>
<tr>
<td>in vit.</td>
<td>in vitro</td>
<td>in glass</td>
</tr>
<tr>
<td>Lb or lb</td>
<td>libra</td>
<td>a pound</td>
</tr>
<tr>
<td>levis</td>
<td>levis</td>
<td>light</td>
</tr>
<tr>
<td>Liq</td>
<td>liquor</td>
<td>a solution</td>
</tr>
<tr>
<td>lotio</td>
<td>lotio</td>
<td>lotion</td>
</tr>
<tr>
<td>M., m, m.</td>
<td>misce</td>
<td>Mix, mix</td>
</tr>
<tr>
<td>mane</td>
<td>mane</td>
<td>in the morning</td>
</tr>
<tr>
<td>Mist</td>
<td>mistura</td>
<td>mixture</td>
</tr>
<tr>
<td>mit</td>
<td>mitte</td>
<td>send</td>
</tr>
<tr>
<td>mite</td>
<td>mite</td>
<td>weak</td>
</tr>
<tr>
<td>molles</td>
<td>molles</td>
<td>soft</td>
</tr>
<tr>
<td>n.</td>
<td>nocte</td>
<td>in the night</td>
</tr>
<tr>
<td>nigrum</td>
<td>nigrum</td>
<td>black</td>
</tr>
<tr>
<td>no.</td>
<td>numero</td>
<td>number</td>
</tr>
<tr>
<td>non. rep., n.r.</td>
<td>non repetatur</td>
<td>do not repeat, not to be repeated</td>
</tr>
<tr>
<td>o.</td>
<td>octarius</td>
<td>pint</td>
</tr>
<tr>
<td>octo</td>
<td>octo</td>
<td>eight</td>
</tr>
<tr>
<td>o.d., od</td>
<td>omne die</td>
<td>every day, daily</td>
</tr>
<tr>
<td>o.d.</td>
<td>oculus dexter</td>
<td>right eye</td>
</tr>
<tr>
<td>o.m.</td>
<td>omni mane</td>
<td>every morning</td>
</tr>
<tr>
<td>o.n.</td>
<td>omni nocte</td>
<td>every night</td>
</tr>
<tr>
<td>o.s.</td>
<td>oculus sinister</td>
<td>left eye</td>
</tr>
<tr>
<td>Ol</td>
<td>olio</td>
<td>oil</td>
</tr>
<tr>
<td>par, pt</td>
<td>pars, partis</td>
<td>a part, of a part</td>
</tr>
<tr>
<td>p.c.</td>
<td>post cibum, post cibos</td>
<td>after meals</td>
</tr>
<tr>
<td>per</td>
<td>per</td>
<td>through, by</td>
</tr>
<tr>
<td>pil</td>
<td>pilula</td>
<td>pill</td>
</tr>
<tr>
<td>placebo</td>
<td>placebo</td>
<td>to please</td>
</tr>
<tr>
<td>p.o.</td>
<td>per os</td>
<td>by mouth</td>
</tr>
<tr>
<td>p.r.n.</td>
<td>pro re nata</td>
<td>as occasion requires, as the occasion arises</td>
</tr>
<tr>
<td>pulv/pul</td>
<td>pulvis</td>
<td>powder</td>
</tr>
<tr>
<td>q.r.</td>
<td>quantum rectum</td>
<td>right/correct quantities</td>
</tr>
<tr>
<td>q.s.</td>
<td>quantum sufficient</td>
<td>sufficient quantity</td>
</tr>
<tr>
<td>quot</td>
<td>quotidie</td>
<td>daily</td>
</tr>
<tr>
<td>q 3 h</td>
<td>quaque 3 hora</td>
<td>every 3 hours</td>
</tr>
<tr>
<td>q 4 h</td>
<td>quaque 4 hora</td>
<td>every 4 hours</td>
</tr>
<tr>
<td>q 6 h</td>
<td>quaque 6 hora</td>
<td>every 6 hours</td>
</tr>
<tr>
<td>q.i.d., qid</td>
<td>quarter in die</td>
<td>four times a day, 4 times daily</td>
</tr>
<tr>
<td>Qq. H</td>
<td>quaque hora</td>
<td>every hour</td>
</tr>
<tr>
<td>Rx</td>
<td>recipe</td>
<td>take, take thou of</td>
</tr>
<tr>
<td>rep</td>
<td>repetatur</td>
<td>let be repeated</td>
</tr>
<tr>
<td>s. s.</td>
<td>sine</td>
<td>without</td>
</tr>
<tr>
<td>s.i.d.</td>
<td>semel in die</td>
<td>once a day</td>
</tr>
<tr>
<td>sig</td>
<td>signa</td>
<td>make/write on the label</td>
</tr>
<tr>
<td>sixt.hor</td>
<td>sixtis horis</td>
<td>every six hours</td>
</tr>
<tr>
<td>Term</td>
<td>Meaning</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------</td>
<td></td>
</tr>
<tr>
<td>sol.</td>
<td>Solutio</td>
<td></td>
</tr>
<tr>
<td>s.o.s., sos</td>
<td>si opus sit if necessary</td>
<td></td>
</tr>
<tr>
<td>spts</td>
<td>spiritus</td>
<td></td>
</tr>
<tr>
<td>ss</td>
<td>semi sse, semis half, one-half</td>
<td></td>
</tr>
<tr>
<td>stat.</td>
<td>statim immediately</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>ter thrice</td>
<td></td>
</tr>
<tr>
<td>tab.</td>
<td>Tabella a tablet</td>
<td></td>
</tr>
<tr>
<td>talis</td>
<td>talis such</td>
<td></td>
</tr>
<tr>
<td>t.i.d.</td>
<td>ter in die three times a day</td>
<td></td>
</tr>
<tr>
<td>tr, tr.</td>
<td>Tinctura tincture</td>
<td></td>
</tr>
<tr>
<td>troch.</td>
<td>trochiscus, torchisci lozenge, lozenges</td>
<td></td>
</tr>
<tr>
<td>unc</td>
<td>uncia an ounce</td>
<td></td>
</tr>
<tr>
<td>ung, ungt, ungt.</td>
<td>unguentum ointment</td>
<td></td>
</tr>
<tr>
<td>ut dict.</td>
<td>ut dictum as directed</td>
<td></td>
</tr>
</tbody>
</table>

**MODEL VETERINARY PRESCRIPTION**

- **Veterinary hospital/clinic**: 
- **Name and address of the doctor/veterinarian**: 
- **Phone no.**: 
- **Date**: 

- **Owner’s name and address**: 
- **Animal species**: Bread Age Sex 
- **Complaint**: 
- **Diagnosis/tentative diagnosis**: 

- **Superscription**: Rx 
- **Subscription**: 

- **Signa**: 
- **Signature with Date**: 

- **Registration no.**: 

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OBJECTIVE
To know the various sources of drugs.

VARIOUS SOURCES OF DRUGS
Various sources of drugs are described below:

A. Natural Source:
- Plant source
- Animal source
- Microbial source
- Mineral source

1. Plant source- This is the ancient source of drugs, collectively called as “medicinal plants”. Their therapeutic value depends upon the presence of one or more active principles which are found in different parts of the plants like root, rhizome, tuber, stem, bark, flower, fruit and seed. For examples-
  - Reserpine alkaloid is obtained from the root of Rauwolfia serpentina.
  - Quinine alkaloid is obtained from the bark of genus Cinchona.
  - Digitalis glycoside is obtained from the leaf of Digitalis lanata/D. purpurea.
  - Atropine alkaloid is obtained from Atropa belladonna.
  - Morphine alkaloid is obtained from the seed capsule of Papaver somniferum.

2. Animal source- Different animal organs or hormones have been used in the treatment of various diseases. For examples-
   - Hormone- Posterior pituitary extract (oxytocin), gonadotropins, insulin,
thyroxin, etc.

✓ Vitamin- Cod or shark liver oil is a rich source of vitamins A and D.
✓ Antiserum- Canine distemper antiserum and anti-snake venom.
✓ Others- Heparin, liver extract, immunoglobulin, blood plasma, etc.

3. **Microbial source**- Bacteria, fungi, *Actinomycetes*, etc. are important sources of antibiotics, e.g., bacitracin, penicillin, streptomycin, gentamycin, neomycin, etc. Viruses and bacteria are used for preparation of vaccines. Dried yeast is used as a source of B complex vitamins.

4. **Mineral source**- Many inorganic salts are used in the treatment and prevention of diseases. For examples-
   - **Purgative**- Magnesium sulphate.
   - **Laxative**- Liquid paraffin.
   - **Antacid**- Magnesium oxide.
   - **Expectorant**- Potassium iodide.
   - **Diuretic**- Potassium nitrate.
   - **Haematinic**- Ferrous sulphate.
   - **Antihypothyroid**- Iodine.

**B. Semisynthetic Source:**

The semisynthetic drugs are produced by the chemical alteration of natural drugs, e.g., semisynthetic penicillin from the penicillin and dihydrostreptomycin from the streptomycin, etc.

**C. Synthetic Source:**

The synthetic drugs are produced through the chemical synthesis. For examples- aspirin, paracetamol, sythetic penicillin, sulphonamides, ethambutol, betamethasone, tetramisole, piperazine, etc.

**D. Drugs Produced by Genetic Engineering/Gene Therapy:**

For examples- human insulin, human growth hormone, and prevention and treatment
of diseases through manipulation of gene function.

E. Biopharmaceuticals:

These are produced through biotechnological means, not by chemical synthesis; e.g., oxytocin, GnRh, ACTH, TSH, streptokinase, asparaginase, monoclonal antibodies, etc.

CHEMICAL COMPOSITION OF DRUGS

Alkaloids:

They are the basic nitrogenous substances insoluble in water, but soluble in organic solvents. They are ammonia compounds, which form crystalline salts with acids, e.g., atropine, quinine, reserpine and morphine. Some alkaloids which have carbon, hydrogen and nitrogen but do not have oxygen are liquid, e.g., nicotine, pilocarpine, lobeline, etc.

The alkaloids such as atropine, morphine, caffeine, arecoline, quinine and cocaine are isolated from the plants Atropa belladonna, Papaver somniferum, Coffea arabica, Areca catechu, Cinchona officinalis and Erythroxylum coca, respectively.

Glycosides:

They are non-nitrogenous bodies, having sugar and non-sugar parts. They are found in plants and have carbon, hydrogen and oxygen. ‘Glucosides’ are those in which sugar part is glucose; e.g., example, digitoxin, digitalin, strophanthidin, amygdalin and ouabain.

Saponins:

They are group of non-nitrogenous substances, usually glycosides soluble in water and form froth and foam. The toxic saponins are called ‘sapotoxins’. On hydrolysis, they form sugar and non-sugar parts, and cause haemolysis of red blood cells (RBCs). For example, quillaria bark and senega root used as emulsifier.

Gum:

They are non-poisonous colloidal carbohydrates obtained as exudates of stems and
branches of plant. They dissolve in water and form mucilage. For example, gum acacia (obtained from the bark/stem of *Acacia nilotica*), gum arabica (from bark/stem of *A. arabica*) and gum tragacanth (from stem of *Astragalus tragacanthus*/A. gummifer). Gum resins are the mixture of gum and resins, and volatile oils, e.g., asafoetida and myrrh.

**Tannins:**

They are non-nitrogenous phenol derivatives found in leaves and barks of many plants. They have astringent action, e.g., catechu, oak galls and kino.

**Fixed Oils:**

Fixed oils are the glyceride ester of fatty acids, e.g., oleic, palmitic and stearic acids. They are pharmacologically inert but serve as vehicle for administration of fat soluble drugs. They are stable and do not evaporate, e.g., castor oil (from the dried seeds of *Ricinus communis*) and linseed oil (from the dried seeds of *Linum usitatissimum*).

**Volatile Oils/Aromatic Oils:**

They have peculiar odour, so they are also essential oils/aromatic oils. They are composed of aldehyde, ketone, ester and sulphur compounds. They are obtained by distillation. For examples, eucalyptus oil (obtained from leaves of *Eucalyptus citriodora*/E. globules/E. maculata), ginger oil (obtained from rhizomes of *Zinziber officinale*), cedar-wood oil (obtained from wood of *Cedrus deodara*/C. libani) and turpentine oil (obtained from leaves and wood of *Pinus palustris*).

**Resins:**

They are the oxidation products of volatile oils. They are composed of acid alcohol or ester. In fact, they are the secretions of plant tissues. They are soluble in alkalis and form resin soaps, e.g., podophyllum resin and jalap.

**Oleoresins:**

The examples of oleoresins are crude turpentine balsams (e.g., oleoresin with
benzoic acid) and gum resins (e.g., asafoetida).

**Waxes:**

The waxes are the ester of higher fatty acids and higher monohydric alcohols. They do not form soaps with alkali, e.g., bees wax and *Spermaceti* wax.

**Enzymes/Ferments:**

They are protein in nature and are organic catalysts, which increase rate of reaction destroyed at 60^0C. Few examples of plant enzymes are pepsin, trypsin, rennin and papain.

**Acids:**

They are the salts of hydrogen, e.g., citric acid, tartaric acid and acetic acid.

**Bases:**

They react with acids to form salts. The elementary bases are sodium hydroxide (NaOH) and potassium hydroxide (KOH). The compound bases are alkaloids.

**Salts:**

They are the compounds of acid and base, e.g., sodium chloride (NaCl) and strychnine hydrochloride.

**Metals:**

Copper (Cu), iron (Fe), zinc (Zn), manganese (Mn) and magnesium (Mg) are some of the examples of metals.

**Metalloids:**

Arsenic (As) and antimony (Sb) are metalloids.

**Non-Metals:**

Water (H\textsubscript{2}O) and sulphur (S) are non-metals.
OBJECTIVE
To know the incompatibility of drugs.

MEANING/DEFINITION OF INCOMPATIBILITY
The term “incompatibility” means the lack of agreement between drugs, or improper combination of drugs which interferes with the elegance, usefulness or safety of a prescription. The “incompatibility” may be applied to the pharmaceuticals when a problem arises during the pharmaceutical compounding of more substances because of their therapeutic, physical or chemical properties. Such substances are said to be ‘incompatible’.

An ‘incompatible prescription’ is one that contains two or more substances which when mixed together yield an unsuitable product. Sometimes, the ‘incompatible drugs/substances’ are mixed together intensively for desired action.

IMPORTANCE OF INCOMPATIBILITY
Improper combination of two or more drugs in a mixture or in a patient can reduce safety and/or efficacy of drugs. Therefore, the incompatibility has its great importance, and the following points should be kept in mind:

1) The knowledge of the incompatibility is necessary for the veterinarians, not only to avoid complications in clinical practice, but also to make the use of incompatibility to reduce/antagonize certain toxic effects of drug(s).

2) A preparation poses an incompatibility when the combination of its ingredients adversely affects its appearance, elegance or therapeutic efficacy.

3) Several incompatibilities and interactions are possible considering a large number of drugs available which may be used in the combination.
4) The mixing of certain drugs together in the same syringe or with intravenous fluids may lead to ‘physical incompatibility’ (change in colour or turbidity) or ‘chemical reactions’ (e.g., complex formation, hydrolysis, oxidation, reduction) and thereby loss of pharmacological activities. The vehicles/preservatives/stabilizers used in the product may also cause ‘drug interaction’.

5) The interactions can result in a lack of therapeutic effect or toxicity. A distinction should be made between the drug interactions which occur in vitro (e.g., in a syringe or vial) from those which occur in vivo (in the patient).

6) The veterinarians frequently mix the drugs together in syringes, vials or fluids before administration to animals. A drug interaction of this nature may form a drug precipitate, a toxic product, or inactive one of the drugs to unknowingly administer an ineffective compound. The compounding drugs which are incompatible may cause in vitro drug interactions.

**TYPES OF INCOMPATIBILITY**

There are three types of incompatibility:

1. Physical incompatibility
2. Chemical incompatibility
3. Pharmacological/therapeutic incompatibility

**1. Physical/Pharmaceutical Incompatibility:**

When all or some of the ingredients in a prescription due to their difference in physical properties do not combine with each other, leads to ‘physical incompatibility’. The ingredients may not be soluble in the solvent, or the mixture of undesirable consistency or colour is formed. e.g., oil and water; bismuth carbonate and water, etc.

This type of incompatibility can be avoided by knowing solubility of different ingredients- all nitrates are soluble except few. Except chlorides, the bromides and iodides of heavy metals are soluble. All hydroxides, carbonates and phosphates are insoluble except the sodium, potassium and ammonium salts. The alaklis are soluble in strong mineral acids and organic acids, but insoluble in alkaline solutions. The
incompatible drugs are used by adding another agent, or by using various pharmaceutical processes, e.g., oil and water can be combined with the help of mucilage as emulsifying agent. The insolubility of kaolin and chalk can be overcome by adding gum acacia or gum tragacanth in preparing antidiarrhoeal powder. Bismuth carbonate can be suspended in gum mucilage.

2. **Chemical Incompatibility:**

In a prescription, sometimes all or some of the ingredients may act upon each other and produce an unsuitable, dangerous or inert compound which leads to the chemical incompatibility. These chemical interactions may be homogenous with no visible change of form, or heterogeneous with some visible change of form such as the production of gas or precipitate. This occurs due to the change in pH or decomposition reaction of the chemicals.

The chemical incompatibility is of two types-

a. **Desirable/intentional incompatibility**- For example in white lotion, lead acetate and zinc sulphate react to form zinc acetate; the lead sulphate is in precipitate form and holds zinc acetate in liquid form which is also an active ingredient to act as an antiseptic and astringent agent.

b. **Undesirable incompatibility**- For examples:

   (i) **Precipitation**- alkaloids and other powerful drugs are prescribed alone.

   (ii) **Gas liberation**- iron salts are mixed with iodide gas, and if carbonates and bicarbonates are mixed with acidic drugs, then gas (CO$_2$) production occurs.

   (iii)**Explosion**- is the direct chemical reaction between two agents, and accumulation of gas in the container occurs.

The chemical incompatibility of therapeutic relevance is described in Table 8.

**Table 8: Chemical Incompatibility in Therapeutics**

<table>
<thead>
<tr>
<th>Drug/Substance</th>
<th>Incompatible with</th>
<th>Result/Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids- e.g., morphine, strychnine and codeine</td>
<td>Soluble iodides and bromides</td>
<td>Insoluble hydroiodides/ hydrobromides</td>
</tr>
<tr>
<td>Alkaloids- e.g., caffeine and strychnine</td>
<td>Alkalis- e.g., Solution of ammonia, borax, calcium hydroxide and sodium/potassium/ammonium bicarbonate</td>
<td>Salt formation</td>
</tr>
<tr>
<td>Alkaloids- e.g., quinine</td>
<td>Benzoates/salicylates</td>
<td>Indiffusible precipitate</td>
</tr>
</tbody>
</table>
3. Pharmacological/Therapeutic Incompatibility:

All or some of the ingredients in a prescription prevent or weaken the action of each other. But this antagonism is partial as no two drugs can fully counteract the action of another drug. This type of incompatibility may be of two types-

a. Pharmacodynamics incompatibility- In this type, the pharmacological action of one drug is altered by another. For example, when atropine and morphine are given together, they neutralize the effect of each other. Similarly, when ammonium hydrochloride is given to birds as a coccidiostat, it leads to deficiency of vitamin B₁. The drugs may act on the same structure and produce opposite effect, e.g., bromide and nux-vomica act on the spinal cord; sulphonamides when given with procaine do not produce desirable effect. Sometimes, the drugs may act on different structures but produce opposite effect on the same organ, e.g., adrenaline constricts blood vessels by acting on the nerve, and nitrites dilate blood vessels by acting on the blood vessels of the muscles.

b. Pharmacokinetic incompatibility- It means that the drug interaction is occurring at the level of absorption, distribution, metabolism or excretion when two or more drugs given together. For examples:

(i) At the level of absorption- when tetracycline is given with the milk, antacid or mineral supplement, the absorption of drug is decreased; the absorption of aspirin and sulphonamides are enhanced due to administration of antacid; and the absorption of fluoroquinolone antibiotics decreases when administered with antacids like aluminium hydroxide.
(ii) At the level of distribution- the non-steroidal antiinflammatory drugs (NSADs) displace warfarin bound to plasma protein.

(iii) At the level of excretion- the excretion of sulphonamides can be favoured (to avoid crystalline urine) by per oral administration of sodium bicarbonate.
THERAPEUTIC USES OF SOME HERBAL DRUGS

OBJECTIVE
To know the therapeutic uses of some herbal drugs.

USES OF SOME DRUGS/INGREDIENTS
The therapeutic uses of some herbal drugs are mentioned in Table 9.

Table 9: Therapeutic Uses of Some Herbal Drugs

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Active Constituent</th>
<th>Therapeutic Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrak</td>
<td>Rhizome of Zingiber officinale (Ada/ginger)</td>
<td>Volatile oils, camphene, gingerol, zingiberene, borneol, cineol, curcumin, proteins</td>
<td>Appetizer, stimulant, digestive, carminative, antiflatulent, antidiabetic, antiinflammatory, antispasmodic, cardioprotective, antioxidant and anticancer/antitumour</td>
</tr>
<tr>
<td>Ajwain</td>
<td>Fruit of Trachyspermum ammi</td>
<td>Essential oils containing thymol</td>
<td>Carminative, digestive, stimulant anticolic, antispasmodic, antiseptic, anticholera, anti-sore throat, anti-pneumonic, anti-diarrhoeal and anticancer/antitumour</td>
</tr>
<tr>
<td>Asafoetida</td>
<td>Rhizome/root of Ferula asafoetida/F. foetida (Hing)</td>
<td>Volatile oils (4-20%), resins (40-65%), gum (25%), essential oils</td>
<td>Carminative, antispasmodic, anticolic, laxative, expectorant, antiflatulent and intestinal antiseptic; also used in infantile convulsion, hysteria, epilepsy and scorpion-sting</td>
</tr>
<tr>
<td>Aswagandha</td>
<td>Root of Withania somnifera</td>
<td>Withanolides (steroidal lactones- withanone, withaferin A, withanolide D and withasonidienone), alkaloids (withasommine and withanine), withanol, acylsteryl glucosides, starch, reducing sugar, glycosides, resins, saponins, fixed oils, hantreacotane, ducitol, amino acids (including aspartic acid, proline, tyrosine, alanine),</td>
<td>General tonic, liver tonic, uterine tonic, astringent, diuretic, aphrodisiac, antiinflammatory, sedative, antidepressant, antistress, anxiolytic, antiangiogenic, anticoagulant, hypoglycaemic, hypocholesterolemic, cardioprotective/cardiotropic, anticonvulsant, adaptogenic, antimalarial, antiarthritic, antimicrobial, antimitotic, viricide, immunomodulating, antioxidant</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Source</th>
<th>Components</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camphor</td>
<td>Stem/root of <em>Cinnamomum camphora</em> (Kapur)</td>
<td>Volatile oils, terpenoids, eugenol, safrole</td>
<td>Stimulant, carminative, antiseptic, diaphoretic, anodyne, sedative, counter-irritant, topical antipruritic and antihelminthic</td>
</tr>
<tr>
<td>Castor oil</td>
<td>Seed of <em>Ricinus communis</em> (Arand/caster)</td>
<td>Fixed oils (45-55%), triricinolein (75%), ricinine, ricinoleic acid</td>
<td>Laxative, cathartic, lubricant, purgative, counter-irritant and antitumour; also given in scorpion-sting and fish poison</td>
</tr>
<tr>
<td>Catechu</td>
<td>Wood/bark of <em>Acacia catechu</em> (Khair/cutch)</td>
<td>Tannins, catechins (α, β and γ), l-epicatechin, catechutannic acid, flavonoids, khair-gum</td>
<td>Astringent, anti-sore throat and expectorant</td>
</tr>
<tr>
<td>Chireta</td>
<td>Whole plant of <em>Swertia chirata</em> (Chirata/ chirayita)</td>
<td>Bitter principle chiratin (not less than 1.3%), swertianin, swertin, swertenol, chiratanin, dye</td>
<td>Bitter, tonic, sialic, febrifuge, stomachic, laxative, anti-asthmatic, hepatoprotective and anticancer/antitumour</td>
</tr>
<tr>
<td>Eucalyptus oil</td>
<td>Leaf of <em>Eucalyptus citriodora/ E. globulus</em> (Eucalypt)</td>
<td>Essential oils (0.5-2%-citronellal, citronellol, cineole and pinene), esters, volatile oils (3-6% eucalyptol and cineole), sesquiterpenes</td>
<td>Burn ointment, antiseptic, anti-skin and respiratory diseases, diaphoretic, anti-asthmatic, expectorant, purgative, febrifuge, and mosquito repellent</td>
</tr>
<tr>
<td>Ghee-kunwar</td>
<td>Whole plant of <em>Aloe vera/A. barbadensis</em> (Ghee-kunvar/ghi-kanvar, Indian aloe)</td>
<td>Aloin, acemannan (a polysaccharide), lectin, isobarbaloin, alexin B, ‘super carbohydrates’, glycosides (anthracene/anthraquinone/ hydroxyanthraquinone derivatives like emodin and barbaloin), chrysophanic acid, uronic acid, oxidase, catalase, sugars, gum, resin, fibre, dye</td>
<td>Stomachic, purgative, emmenagogue, antihelminthic, anti-piles, anti-rectal fissures, cathartic, cooling/refrigerant, anti-colic, anti-contipation, menstrual stimulator, anti-liver, spleen and skin diseases, anti-eye troubles, anti-burns, immunoenhancing, antioxidant and anticancer/antitumour</td>
</tr>
<tr>
<td>Haldi</td>
<td>Dried rhizome of <em>Curcuma longa</em> (Turmeric)</td>
<td>Curcuminoids (e.g., curcumin, i.e., diferuloyl methane), volatile or fixed oils, bitter substances</td>
<td>Tonic, choleric, cholagogue, blood purifier, alterative, aromatic, stimulant, carminative, antiseptic, hepatoprotective, antiperiodic, antimicrobial, antimutagenic, antioxidant, immunostimulant, antiinflammatory, radioprotective and anticancer/antitumour</td>
</tr>
<tr>
<td>Isubgol</td>
<td>Seed and husk of <em>Plantago ovata</em> (Ispaghul/ isphagula)</td>
<td>Polysaccharides, mucilages, holoside planteose (0.168%), fatty oils</td>
<td>Bulk laxative, cooling, diuretic, demulcent, expectorant, anti-constipation, anti-diarrhoel, anti-dysentery, and GIT and genito-urinary antiinflammatory</td>
</tr>
<tr>
<td>Nux-vomica</td>
<td>Dry ripe seed and whole plant of <em>Strychnos</em></td>
<td>Alkaloids (2.5-5.0%-strychnine not less than 1.2% and brucine), loganin</td>
<td>Bitter, tonic, stomachic, sialic, febrifuge, aromatic, anti-colic, antiemetic, antipyretic, anti-</td>
</tr>
<tr>
<td><strong>nux-vomica</strong> <em>(Kuchla/kajra bailewa)</em></td>
<td>glucoside, fixed oils</td>
<td>dysentery, anti-cholera, antiflatulent, anti-ulcer, anti-wound and anti-maggot</td>
<td></td>
</tr>
<tr>
<td><strong>Pepper</strong></td>
<td>Fruit and root of <em>Piper longum</em> <em>(Pipal/pipli/piplamul/Indian long)</em></td>
<td>Alkaloids (piperine and pipatine), triacantone, dihydrostigmasterol, steroid</td>
<td>Alterative, tonic, carminative, purgative, cough expectorant, antiseptic, anti-haemorrhoidal, counter-irritant and analgesic for muscular pain and inflammation, snuff in coma and drowsiness, sedative, cholangogue, sialogogue, emmenagogue, abortifacient, rubefacient, affect ciliary movement, suppress cough reflex, and antidote to snake-bite and scorpion-sting</td>
</tr>
<tr>
<td><strong>Piyaz</strong></td>
<td>Bulb of <em>Allium cepa</em> <em>(Pyaz/onion)</em></td>
<td>Diallyl disulphide, quercetin flavonoid, allicin, allin, vitamins (C, E and folic acid), amino acids</td>
<td>Stimulant, heart stimulant, digestive, expectorant, cooling, diuretic, antiseptic, analgesic, antipyretic, anti-diabetic, anti-dysentery, anti-inflammatorv, emmenagogue, aphrodisiac, antiflatulent, anticholesterol, bactéricidal and anticancer/antitumour; also applied as poultice over swellings/blisters/boils</td>
</tr>
<tr>
<td><strong>Tulsi</strong></td>
<td>Leaf and stem of <em>Ocimum sanctum</em></td>
<td>Volatile oils (0.7%-eugenol, methyl eugenol, carvacrol and sesquiterpine), phenolic compounds (circilineol, circimaritin, isothymusin, apigenin and rosamic acid), flavonoids (orientin and vicenin), usric acid, apigenin, luteolin, apigenin-7-O-glucuronide, luteolin-7-O-glucuronide, molludistin, monoterpines (bornyl acetate, β-elemene, neral, α- and β-pinenes), camphene, campesterol, cholesterol, stigmasterol, β-sitosterol</td>
<td>Antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, antihelmintic, anti-diarrhoeal, analgesic, antipyretic, CNS depressant, antiinflammatory, anti-allergic, antihypertensive, cardioprotective, memory enhancer, antileucodermal, hepatoprotective, antihypercholesterolaemic, anti-diabetic, antiasthmatic, antithyroidic, antioxidant, anticancer, chemopreventive, antithyroidic, antioxidant, anticancer, chemopreventive, radioprotective, anticataract, anticoagulant, antiarthritic, immunomodulatory, antifertility, antifulcer, adaptogenic and antistress</td>
</tr>
<tr>
<td><strong>Turpentine oil</strong></td>
<td>Leaf and wood of <em>Pinus palustris</em> <em>(Pine/longleaf pine)</em></td>
<td>Terpeneoils (33% α-pinene and β-pinene), resins</td>
<td>Antizymotic and counter irritant</td>
</tr>
</tbody>
</table>
STANDARDS AND REGULATIONS OF DRUGS

OBJECTIVE
To know the standards and regulations of drugs.

DRUG STANDARDS

Meaning/Definition and History of Pharmacopoeia:

The term “pharmacopoeia” has been derived from the two Latin words- ‘pharmacon’ meaning the ‘drug’; and ‘poeia’ meaning the ‘make’. “Pharmacopoeia” is ‘a class of drug compendia published under the authority of a recognized body, normally constituted by law to ensure uniformity in composition and strength of medicines used in the treatment of diseases’. Thus, pharmacopoeia is ‘an official book of standard for drugs’. The drugs and preparations described in this book are the ‘official drugs’. So, pharmacopoeia is the standard which must be followed in drug preparation. These official documents contain a selected list of drugs and preparations with the description of the standard of their physical and chemical properties, and test for their identity, purity and potency.

Each nation may be having its own pharmacopoeia. Historically, the pharmacopoeia was published by the Municipals, e.g., ‘Pharmacopoeia of London’ (1618) and ‘Pharmacopoeia of Paris’ (1630). Nowadays, the pharmacopoeia is published by the Government of country. The first national pharmacopoeia, ‘Codex Medica Mentarius’ of France was published in the year 1819; whereas, the first ‘US Pharmacopoeia’ (USP) was published in 1820. Similarly, the first legalization concerned with the ‘Drug Regulation’ was acted in England in the year 1872. In USA, such laws were made by the US Congress. It was the responsibility of US Food and Drug Administration (FDA), Department of Health, Education and Welfare to implement these laws.
**Different Pharmacopoeias/Drug Reference Sources:**

1. **Indian Pharmacopoeia (IP)** - It is the standard book for drugs included in India, under the ‘Drugs and Cosmetics Act (1940)’. The ‘Government of India, Ministry of Health and Family Welfare’ notifies the members of the committee for scrutinizing and updating IP (drugs recommended for human and veterinary medicine) at regular intervals. The IP was published in 1844 as ‘Bengal Pharmacopoeia’ with the general concept of medicinal plants. It was prepared by William Brook O. Shangnersy, and was published by the then Government. Its main focus was on the indigenous drugs. However, the first pharmacopoeia of India was published in 1868. It was prepared under the authority of Secretary of State for India along with the IP committee constituted in 1865. This was edited by Edward John Waring. It contains some indigenous drugs and drugs of ‘British Pharmacopoeia’ (BP). Mooden Sheriff prepared a supplement of IP in 1869. In 1900, the Indian and colonial addendum to BP was published. It was again published with certain modifications in 1901. Then the Government of India published a ‘reference book’, named as the “Indian Pharmacopoeia” (IP) in 1946 to set up the standard of drugs. In 1948, an Indian pharmacopoeial committee was constituted who prepared the ‘Pharmacy of India’, which again called as “IP” in 1955. Hence, the IP was first published in 1956. A supplement to this was published in 1960. This pharmacopoeia contains western as well as the traditional drugs, and the same policy continued while preparing the IP (1966) and IP supplement (1975). In IP (1985), and its addenda 1909 and 1991, the traditional drugs were not included since the publication of pharmacopoeia of traditional system drugs was taken up separately; and only those drugs were included which have supportive definitive quality control standards. Later on, the IP was published in December, 1996. A veterinary supplement of this IP was published in the year 2000. The IP is usually published at every 5 years interval.

2. **International Pharmacopoeia (Ph.I.)** - It is a publication of ‘World Health Organization’ (WHO) compiled by the appointed experts.

3. **Indian Pharmaceutical Codex (IPC)** - It was published by ‘Council of Scientific
4. National Formulary of India (NFI)- The first NFI was published by the ‘Government of India, Ministry of Health’ in the year 1960.

5. British Pharmaceutical Codex (BPC)- The BPC was published by the ‘Pharmaceutical Society of Great Britain’. It gives the formulations similar to BP along with uses, and details of toxicity and their antidotal measures.

6. British Veterinary Codex (B. Vet. C.)- The B. Vet. C. is similar BPC, and was published under the direction of ‘Council of Pharmaceutical Society of Great Britain’. It recommends the standard for substances and preparations used in prophylaxis and treatment of animal diseases along with information, action and uses of these substances and preparations.

7. British Pharmacopoeia (BP)- The first BP was published in 1864. It is being published at every 5 years.


9. Extra Pharmacopoeia (EP)- It is published under the direction of ‘Council of Pharmaceutical Society of Great Britain’. It contains the statements of drugs given in pharmacopoeia, formulary and codex of various countries of the world.

10. United State Pharmacopoeia (USP)- The first edition USP was published in 1820, and was revised after every 10 years up to 1940. Now, it is being revised at every 5 years.

11. United States National Formulary (USNF)- The USNF is published and revised by the ‘American Pharmaceutical Association’ at every 5 years simultaneously with the USP.

12. United States Dispensary (USD)- The USD is useful encyclopedia type of commentary on official and non-official drugs found throughout the world. It is published by the ‘Council of American Pharmaceutical Association’. It is a non-official publication.

13. New and Non-Official Drugs (NND)- The NND is published yearly by the
‘Council on Drugs of American Medical Association’. It contains information on the pharmacological action and therapeutic efficacy of drugs. It examines the safety and hazards of drugs, and takes care of the false advertisements.

14. Accepted Dental Remedies (ADR)- The ADR is published annually by the ‘Council of Dental Therapeutics of American Dental Association’ to evaluate the dental products. It is comparable to NND.

15. Physician Desk Reference (PDR)- The PDR provides essential information by manufacturing concerned with the pharmaceutical products.

DRUG REGULATIONS

The regulatory agencies are governmental bodies constituted by different Acts for overseeing restrictions imposed on citizens or organizations of citizens in their utilization of drugs and chemicals. Of many agencies, three are most important in USA: (a) ‘Environmental Protection Agency’ (EPA) governs the matters concerning air and water pollution, use of chemicals and pesticides affecting environment; (b) ‘Food and Drug Administration’ (FDA) regulates the use of drugs and food additives; and (c) ‘Drug Enforcement Administration’ (DEA) regulates the manufacturing, distribution and dispensing of controlled substances/drugs.

All the controlled drugs are classified into five “Schedules”- Schedule I, II, III, IV and V, depending on the extent of the abuse potentiality- physical or psychic dependence.

The followings are some of the ‘Acts and Rules’ in India which regulate the “Drugs Rules and Regulations”:

b. The Central Drugs and Cosmetics Rules, 1945.
c. The Pharmacy Act, 1948.
e. The Narcotic Drugs and Psychotropic Substances Act, 1985.
f. The Poison Act, 1919.
g. The Drugs (price control) Order, 1987.
The Drugs and Cosmetic Act, 1940:

The Central and State Governments can appoint “Drug Analyst” with prescribed qualification. The Government can appoint “Drug Inspector” who possesses the requisite qualification for supervision of manufacture/sale and prescription of drugs. The drug inspector can confiscate the spurious/illegal drugs or their combinations and subject it to quality testing by a Government drug analyst. The drug analysis report submitted by analyst will be taken as conclusive evidence in court. If the report is challenged, the drug will be sent to the ‘Central Drugs Laboratory’ whose decision will be binding on both the parties.

Under the ‘The Drugs and Cosmetic Act, 1940’, the import of substandard, misbranded, spurious, adulterated drugs/cosmetics are banned. This Act also prohibits the manufacture of drugs for sale/distribution/stock of drugs which is not of standard quality, does not bear on the label true formula/lists of active ingredients together with qualities or claims to cure but mitigate the diseases.

The Central Drugs and Cosmetics Rules, 1945:

These rules under the ‘Drugs and Cosmetic Act, 1940’ have been amended from time to time to regulate the licensing, import, compounding, dispensing, storage and sales of drugs and cosmetics in India. These rules categorize the drugs and cosmetics under different “Schedules” as mentioned below-

4. **Schedule A**- describes the type of forms required for licensing, import, analysis, testing of drugs and cosmetics.

5. **Schedule B**- describes the fee for test or analysis by the ‘Central Drugs Laboratory’.

6. **Schedule C**- describes the biological means (e.g., sera, toxins and antigens) and special products (e.g., drugs belonging to digitalis group and ergot preparations).

7. **Schedule D**- describes the substances not intended for medicinal use (i.e., bulk purchase of medicinal drugs), e.g., lactose, condensed milk, powdered milk, etc.

8. **Schedule E**- includes the list of poisonous substances under the “Ayurvedic and Unani System of Medicines”.

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9. **Schedule F**- describes the vaccines, antitoxins and standard for surgical dressings.

10. **Schedule G**- describes the substances dangerous to be taken except under the close medical/veterinary supervision.

11. **Schedule H**- includes all the drugs prescribed by a doctor; and the prescribed drugs are to be sold by retail on prescription by the ‘Registered Medical/Veterinary Practitioner’ only.

12. **Schedule I**- has been omitted.

13. **Schedule J**- describes the list of diseases or ailments for which no drug should claim prevention or cures, e.g., leucoderma, cancer, appendicitis, etc.

14. **Schedule K**- includes the drugs meant for medicinal use of for ‘Medical Practitioner’ for supplying to his patients.

15. **Schedule L**- has been omitted.

16. **Schedule M**- describes the pharmacy requirements (factory premises) for preparing a drug.

17. **Schedule N**- includes the list of minimum equipments for running of pharmacy.

18. **Schedule O**- describes the standards for disinfectant fluids.

19. **Schedule P**- describes the life-period of drugs including their combinations with other drugs.

20. **Schedule Q**- includes the list of colours permitted to be used in cosmetics.

21. **Schedule R**- describes the standards for substances other than food intended to affect the structure/function of human body, e.g., contraceptives.

22. **Schedule S**- describes the standards for cosmetics.

23. **Schedule T**- describes the requirements for factory premises for preparation of Ayurvedic and Unani medicines.

24. **Schedule U**- describes the particulars to be shown in the manufacturing records.

25. **Schedule V**- gives the details of standards of patent and proprietary medicines.

26. **Schedule W**- describes the names of drugs which shall be mentioned under generic name only.

27. **Schedule X**- gives the list of restricted (controlled) drugs/substances, e.g., phenobarbitone, amphetamine, etc.
28. Schedule Y- describes the specific trials, import and manufacture of new drugs.

The Poisons Act, 1919- Act II of 1930:

This is an act to consolidate and amend the law regulating the importation, possession and sale of poisons. It describes the power of Government to regulate the possession for sale and sale of any poison; power to prohibit the importation into India of any poison except under license; and power to issue the search warrant and penalty for unlawful importation as to the specified poisons.

The Narcotic Drugs and Psychotropic Substances Act, 1985:

This act is responsible-

1. To consolidate and amend the law relating to narcotic drugs;
2. To make strict provisions for the control and regulation of operations relating to narcotic drugs and psychotropic substances.
3. To provide for the forfeiture of property derived from, or used in, illicit traffic in narcotic drugs and psychotropic substances.
4. To implement the provisions of the ‘International Conventions on Narcotic Drugs and Psychotropic Substances’, and for matters connected therewith.
OBJECTIVE
To know about the safe custody of poisons.

HANDLING AND CUSTODY OF POISONS
“Poisons” are harmful substances, so they should be kept in separate locked wooden or iron almirah. The possession of key should be with the ‘Practitioner’. The container/bottle containing poison should be marked with the sign of ‘Danger’ on its label.

All the aspects of poisonous substances are governed by the rules and regulations as prescribed by the Government under ‘The Poisons Act, 1919’. The poisonous substances should be handled with utmost care as they can produce hazardous effects on the surroundings/individuals.

The following points should be kept in mind while handling the poisonous substances/chemicals/drugs:
1. Read the prescription carefully and identify if a substance is a poison or controlled drug.
2. The containers/bottles containing poisonous substances must have an extra label, preferably ion red colour written with ‘poison’.
3. The containers/bottles of similar size, shape or colour are never to be kept in the close proximity.
5. Do the exact measurement of weight and volume of the toxic substances/poisons.
6. Have extreme cleanliness and precaution to avoid the inhalation of poisons accidentally.
7. The poisonous substances are to be stored under the lock and key in separate almirah under some responsible persons.
8. Precautions must be taken to avoid the possibility of leakage from the stored containers/bottles while storing, handling and transporting the poisons.

9. A register must be maintained with the record of the supply of poisons, their serial numbers, entry and signature of the qualified person under whose supervision the medicine was made up and supplied.

Some of the guidelines for handling the poisonous substances during working in the laboratory are as under:

i. Identify the substance as poisonous/non-poisonous/controlled by reading the label information.

ii. The ‘poison container/bottle’ may have an extra label/special identification mark, indicating the extent of poisonous hazard.

iii. Avoid the direct contact of poisons with the body parts.

iv. Proper closing of the ‘poison container/bottle’ and proper storage of the poisonous substances must be done to avoid the leakage.

v. Keep the poison away from the children and pets.

vi. Proper maintenance of the records must be associated with the poison.

vii. Proper disposal of the poisonous substances should be done as per the regulations.

viii. Other rules and regulations of ‘The Poisons Act, 1919’ should also be followed.
PRINCIPLES AND CONTAINERS FOR COMPOUNDING/DISPENSING OF DRUGS

OBJECTIVE
To know the principles and various containers for compounding/dispensing of drugs.

PRINCIPLES OF COMPOUNDING/DISPENSING

“Compounding” relates to the pharmacy, and includes the preparation, mixing, assembling, packaging or labeling of a drug in response to a prescription written by a licensed practitioner. The ‘extemporaneous compounding’ is defined as the timely preparation of a drug product according to a physician’s prescription, a drug formula, or a recipe in which the calculated amounts of ingredients are made into a homogeneous (uniform) mixture. Extemporaneous compounding is done when certain medical needs of individual patients can not be met by the use of an approved commercial drug product.

Nowadays, most dosage forms of medications are pre-packaged by the manufacturers and, so the pharmacist’s role is more in the redistribution of medicines and clinical aspect of pharmaceutical care. The role of pharmacy technician is still there as the technicians are doing many dispensing functions once reserved for the pharmacist alone. The pharmacy technicians are also doing extemporaneous compounding of medicines.

“Liquids” (e.g., solutions and suspensions) are the most common form of compounded medications. A ‘solution’ is a clear liquid in which the drug is completely dissolved. A ‘dilute solution’ contains a very small amount of particles or solute in the solution; a ‘concentrated solution’ contains large quantities of solute in the solution; and a ‘saturated solution’ contains the maximum amount of solute which can be dissolved in a solvent, or at a given temperature or pressure. A ‘suspension’ is a liquid preparation which contains fine drug particles that are distributed uniformly throughout the solution,
e.g., the reconstitution of an antibiotic like amoxicillin. The suspensions always require shaking before use.

When the “solid” is required in a solution, it is important to reduce the particle size of the solid by using the mortar and pestle (trituration). In some cases, the incorporation of other agents are needed to ensure finer particle size and in the case of suspensions, to ensure even distribution of particles.

“Dispensing” is the mode of labeling and dispatching of medicines in proper dosage forms for immediate use of the patient.

CONTAINERS FOR DIFFERENT PREPARATIONS

I. Containers for Liquid Oral Preparations (for elixir, emulsion, mixture, syrup, etc.):
   (i) For those intended to be swallowed- The containers should be colourless glass bottles/phials and light resistant emulsion type of polyvinyl chloride bottles.
   (ii) For those not intended to be swallowed (mouthwash, thorax paint, etc.)- The containers should be fluted or ribbed oval bottles.

II. Containers for Other Liquid Oral Preparations (for liniment, lotion, paint, etc.):
   The containers should be coloured fluted bottles.

III. Containers for Semisolid Preparations (for cream, ointment, paste, electuary, etc.):
   In this case, the containers should be collapsible metal or plastic tubes. When the larger quantities of containers are required, they should be wide mouthed squat glass/plastic pots, gallipots or waxed papers.

IV. Containers for Solid Unit Dose Preparations (for capsule, pill, tablet, etc.):
   For this purpose, the amber glass, rigid opaque plastic or extruded aluminium airtight containers are generally used. The coloured containers like paper board boxes for foil and blister packed tablets are also used.
V. Containers for Powders:

For this purpose, the wide mouthed colourless screw capped glass jars, and plastic and paper lined aluminium containers are used. For externally used dusting powders, the airtight glass or plastic jars with lids are used.
PROCEDURES FOR COMPOUNDING AND DISPENSING OF DRUGS

OBJECTIVE

To study about the compounding and dispensing of drugs.

LABELING OF DRUGS

“Labeling” is the important step for dispensing of medicines. No bottles or packets containing drugs should be left unlabeled.

The following points to be noted before the labeling any drug:

1. Name of place from where the drug is dispensed.
2. For non-poisonous drugs, name of place should be written in bold letters with ‘black ink’ on white background. For poisonous drugs, it should be written in bold letters with ‘red ink’ on white background with an extra label, “Poison”.
3. Etching of names of drugs for bottles of acid and oils should be done.
4. Information should be written in English and/or local vernacular language.
5. Ambiguous abbreviations which may have different meanings, e.g., acid, sulp., conc. should not be written on the label.

COMPOUNDING OF DRUGS

1. Prescription should be read properly. In case of any doubt, consult the prescriber, or read the standard text book.
2. Prescription should be copied onto the register as a ‘written document’.
3. Remove the old label from the bottle before pouring another medicine.
4. Label should be written before actual dispensing is done, so that you can remember the quantity of drugs to be used in dispensing the drugs.
I. **Weighing of Drugs:**

Before preparation of drug, it should be weighed accurately. For weighing of any drug, the following precautions should be taken-

a) The ‘chemical balance’ should be tested for its accuracy.

b) Do not place the drugs directly on the pan of the ‘chemical balance’.

c) A piece of white paper, preferably butter paper should be placed on the pan and then the drug should be weighed.

d) Corrosive drugs should be weighed on the glass pan.

e) Drugs to be weighed should be placed on right pan and the weights on left pan.

f) Before putting or removing the drugs, the balance should be brought to rest for the accuracy.

g) Powder, knife or spatula should be used to transfer the drugs.

h) After each weighing, the balance should be wiped and cleaned.

There are two types of balances used in the pharmacy lab-

A. **Single beam equal arms balance**- It consists of simple light but rigid beam, divided into two equal arms.

B. **Single pan balance**- Usually, the ‘electronic balances’ are used to weigh the small quantities of drug. Small fractions or grains of medicines are to be weighed only on the chemical balance or electronic balance. If the drugs are weighed without chemical balance, then weigh one grain of substance and mix a definite quantity of diluent. Then from this mixture, weight out the required quantity of drug. For example, weigh one grain of strychnine hydrochloride and to this, mix 19 grains of lactose to make it 20 grains. Then from this mixture, weigh one grain which will contain 19/20 grains of lactose.

II. **Measuring of Drugs:**

a) While pouring out the liquid medicine, the label should be kept uppermost, so that during pouring of the liquid drops, the label does not stain by the drops of medicine.

b) If any drop of liquid medicine is hanging from tip of the bottle, catch hold of it by
the bottom of the stopper before fixing the stopper.
c) To measure the large volume of liquid, the glass measuring vessels are generally used for dispensing purpose.
d) For measuring the poisonous liquids, the pipette with a piston may be used.
e) Even if two drugs are equally effective, do not replace them.

**DISPENSING OF DRUGS**

“Dispensing” is the art of labeling and dispatching of medicines/drugs generally for the immediate use of patients.

**I. Powders:**

a) Clean and unused paper should be used for dispensing of powders.
b) Powder should be packed in the paper as such that it should be folded to equal size, rectangular, and the flaps should be turned back.
c) When all the powders have been flapped, arrange them with all the flaps in one direction and last turned in opposite direction.
d) Encircle the folded powders with thread or elastic bands and dispense in envelops, cardboard boxes or wide mouthed bottles depending on the size and number of powders.

**II. Mixtures:**

a) Mixtures should be dispensed in the dispensing vials. The paper marker can be posted to denote the dose of a particular mixture.
b) All mixtures should be thoroughly shaken, and the volatile and poisonous drugs should be added lastly.
c) Shake the bottle before use. The label should be placed when mixture does not form complete solution.

**III. Electuaries:**

They should be dispensed in gallipots or waxed papers.
IV. Pills:

They are dispensed in pill boxes. If pill is less than one grain, make it to one grain by adding calcium lactate. French chalk is used to prevent the pills sticking together.

V. Balls:

By adding common mass, the ball is made to 2 ounces, and each is wrapped in the tissue paper.

VI. Liniments and Lotions:

Liniments and lotions are dispensed in blue bottles of distinctive designs. If the drug reacts with the light, it should be kept in amber coloured bottle. In the bottles of liniments, place a label written with “For External Use Only”.

VII. Ointments:

Ointments should be dispensed in the gallipots. The drug is treated and mixed with vehicle. For example, the extracts should be concentrated, and the crystalline drugs should be finely powdered.

VIII. Vehicles/Excipients:

These are the agents which facilitate the administration of drug. They act as diluents of the solvent. They mask the offensive odour or bad taste. Some of the agents used as vehicles are-

1. Water- e.g., distilled water is used for injection.
2. Medicinal water- e.g., aqua cinnamon, aqua camphorae and aqua chloroformae.
   All these substances contain active principles. The medicinal water also acts as preservative and flavouring agent.
3. Suspending agents- e.g., gum acacia, gum tragacanth, glycerine, syrup and gruel.
4. Diluents for pills and powders- e.g., calcium, lactose, lactate and glucose (sometimes).
5. Vehicle for electuaries- e.g., honey and syrup.
6. **Vehicle for boluses**- e.g., equal amount of linseed meal or gum acacia and gum tragacanth.

7. **Vehicle for liniments**- e.g., soap solutions, alcohol and water.

8. **Vehicle for ointments**- e.g., soft or hard paraffin, wax, wool and fat.

9. **Vehicle for irritants**- e.g., linseed oil, gum acacia and gruel.
OBJECTIVE
To prepare and dispense some ointments.

PREPARATION AND DISPENSING OF SOME OINTMENTS

1. **Iodine Ointment (Unguentum Iodi):**
   - **Composition** - The composition of 10 g of iodine ointment for animal is as under-
     - Iodine - 0.4 g;  
     - Potassium iodide - 0.4 g;  
     - Glycerin - 1.0 ml;  
     - Petroleum jelly - as required to make 10 g of iodine ointment
   - **Method** - Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.
   - **Use** - It is antiinflammatory and applied in eczema, mange and wounds.

2. **Red Iodide of Mercury Ointment:**
   - **Composition** - The composition of 10 g of red iodide of mercury ointment for animal is as under-
     - Red mercuric iodide - 1.25 g;  
     - Petroleum jelly - as required to make 10 g of iodine ointment
   - **Method** - Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.
   - **Use** - This ointment is used as a counter-irritant and vesicant/blistering agent.
3. **Boric Acid Ointment:**

**Composition** - The composition of 10 g of boric acid ointment for animal is as under-
- Boric acid- 1 g; Petroleum jelly- 9 g

**Method** - Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

**Uses** - The boric acid ointment is used as an antiseptic, antipruritic and soothing agent in skin affections over the wounds and burnt areas.

4. **Zinc Oxide Ointment:**

**Composition** - The composition of 10 g of zinc oxide ointment for animal is as under-
- Zinc oxide- 2 g; Petroleum jelly- 8 g

**Method** - Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

**Use** - This ointment is used as an antiseptic in superficial wounds and ulcers.

5. **Sulphur Ointment:**

**Composition** - The composition of 10 g of sulphur ointment for animal is as under-
- Sulphur- 1 g; Petroleum jelly- 9 g

**Method** - Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

**Use** - The sulphur ointment is used as an antifungal in ringworm, mange and eczema.
OBJECTIVE
To prepare and dispense some powders.

PREPARATION AND DISPENSING OF SOME POWDERS

1. Antidiarrhoeal Powder:
   Composition- The composition of antidiarrhoeal powder for animal is as under-
   Magnesium carbonate- 1g; Bismuth sub nitrate- 1 g; Sodium bicarbonate- 1 g
   Method- Weigh the above chemicals/ingredients and put them in mortar and pestle,
   and triturate them. Finally, dispense the mixture in dispensing vial with the labeling
   instruction of composition, use and dosage.
   Use- This antidiarrhoeal powder is given in flatulence, dyspepsia and gastric ulcer.

2. Triple Carb Powder:
   Composition- The composition of triple carb powder for animal is as under-
   Magnesium carbonate- 1 g; Bismuth carbonate- 1 g; Sodium bicarbonate- 1 g
   To prepare 3 doses, add all the above contents 3 g each.
   Method- Weigh the above chemicals/ingredients and put them in mortar and pestle,
   and triturate them. Finally, dispense the mixture in dispensing vial with the labeling
   instruction of composition, use and dosage.
   Use- The triple carb powder is used as an antacid in hyperacidity and vomition in
   dogs and cats. This is also used to control the irritation of GIT as in case of diarrhoea.
3. **Dusting Powder- I:**

**Composition**- The composition of 30 g of dusting powder for animal is as under-

- Salicylic acid- 5 g;  
- Tannic acid- 5 g;  
- Zinc oxide- 10 g;  
- Talcum powder- 10 g

**Method**- Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

**Use**- This dusting powder is used as an antiseptic, ectoparasiticide, protectant and soothing agent in skin affections.

4. **Dusting Powder- II:**

**Composition**- The composition of 50 g of another dusting powder for animal is as under-

- Camphor powder- 2 g;  
- Sublimed sulphur- 4 g;  
- Boric acid- 4 g;  
- Talcum powder (hydrous magnesium silicate)- 20 g;  
- Starch- 20 g

**Method**- Weigh the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

**Use**- The above dusting powder is used as an antiseptic, ectoparasiticide, protectant and soothing agent in skin affections.
COMPOUNDING AND DISPENSING OF MIXTURES

OBJECTIVE

To prepare and dispense certain mixtures.

PREPARATION AND DISPENSING OF CERTAIN MIXTURES

1. *Mistura alba* (*Alba Mistura)*:

   This is also called “magnesium sulphate, white or saline mixture”. It is called *‘mistura alba’* as it is white in colour and contains insoluble but diffusible substances.

   **Composition** - The composition of 25 ml of mistura alba for animal is as under-
   - Magnesium sulphate - 650 mg
   - Magnesium carbonate - 4 g
   - Distilled water - 25 ml

   **Method** - Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

   **Use** - The mistura alba is used as a laxative and antacid in dogs.

2. *Carminative Mixture*:

   **Composition** - The composition of 25 ml of this mixture for animal is as under-
   - Liquid formaldehyde - 3.0 ml
   - Tr. ginger - 2.5 ml
   - Distilled water - as required to make 25 ml of carminative mixture

   **Method** - Measure the above chemicals/ingredients and put them in a beaker or measuring cylinder. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

   **Use** - It expels gases from stomach in tympany and bloat conditions of large animals.
COMPOUNDING AND DISPENSING OF LINIMENTS

OBJECTIVE

To prepare and dispense the liniments.

PREPARATION AND DISPENSING OF LINIMENTS

Composition- The composition of 25 ml of ammonia liniment for animal is as under-
Camphor- 3.0 g; Strong solution of ammonia- 6.25 ml;
Alcohol (90%)- as required to make 25 ml of ammonia liniment

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

Use- This is a counter irritant and vasodilator, and used in myalgia and sprains.

DIFFERENCE BETWEEN LINIMENT AND LOTION

The differences between liniment and lotion are described in Table 10.

Table 10: Difference between Liniment and Lotion

<table>
<thead>
<tr>
<th>Liniment</th>
<th>Lotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is applied on unbroken skin.</td>
<td>It is applied on mucous membrane and skin, including broken skin.</td>
</tr>
<tr>
<td>It is applied with friction (rubbing).</td>
<td>It is applied without friction.</td>
</tr>
<tr>
<td>It has irritant and counter-irritant actions.</td>
<td>It has antiseptic and soothing actions.</td>
</tr>
<tr>
<td>In this, the solvent is generally alcohol, oil or soap solution.</td>
<td>In this, the solvent is generally water or alcohol.</td>
</tr>
<tr>
<td>It generally contains camphor.</td>
<td>It does not contain camphor.</td>
</tr>
</tbody>
</table>
OBJECTIVE
To prepare and dispense certain lotions.

PREPARATION AND DISPENSING OF SOME LOTIONS

1. *Calamine Lotion*:
   
   **Composition**- The composition of 125 ml of calamine lotion for animal is as under-
   
   - Calamine powder- 19 g; Zinc oxide- 6 g; Bentonite- 4 g; Glycerine- 6 ml;
   
   - Distilled water- as required to make 125 ml of calamine lotion
   
   **Method**- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.
   
   **Use**- The calamine lotion is used in eczema, burn, pruritus, contact dermatitis and insect bite, and as a soothing agent.

2. *Golden Lotion*:

   **Composition**- The composition of 25 ml of golden lotion for animal is as under-
   
   - Calcium hydroxide- 2.5 g; Sulphur- 5.0 g; Distilled water- 25.0 ml
   
   **Method**- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. With the presence of water, the mixture is heated and the change in colour is seen as ‘golden colour’. Finally, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.
   
   **Use**- The golden lotion is topically applied as an insecticidal in animals.
COMPOUNDING AND DISPENSING OF LIQUORS

OBJECTIVE
To prepare and dispense some liquors.

LIQUOR/SOLUTION AND ITS TYPES
It is a homogeneous liquid preparation of non-volatile soluble drugs in water or any other suitable solvent. Although ‘solution’ means various preparations in which a solid or liquid is homogeneously mixed with a liquid (viz., mixture, syrup, lotion, liniment, etc.).

The ‘official liquor’ includes those homogeneous preparations which do not fit under mixture, syrup, lotion, liniment, etc. These official liquors (solutions) consist of:

(a) Solutions of potent substances to avoid the necessity of frequent weighing in very small quantities (e.g., strychnine hydrochloride solution); or
(b) Substances which otherwise are unstable if not kept in solution.

Examples of liquors are:

i. For internal administration- e.g., calciferol solution and morphine solution.

ii. For external application- e.g., calcium hydroxide solution, lead subacetate solution and aluminium acaetate solution.

iii. For antiseptics and disinfectants- e.g., cetrimide, hydrogen peroxide solution and formaldehyde solution.

PREPARATION AND DISPENSING OF SOME LIQUORS

1. Hydrogen Peroxide Solution:
   Composition- The composition of 500 ml of hydrogen peroxide solution for animal
is as under-

Hydrogen peroxide (70%)- 50 ml;
Distilled water- 450 ml required to make 500 ml

Method- Measure the above chemicals/ingredients in a beaker/flask/measuring cylinder and dispense the solution in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- This solution acts as an antiseptic and disinfectant, and is indicated for abscess, wound and fistulous tract.

2. Strong Lead Subacetate Solution:

   Composition- The composition of 500 ml of strong lead subacetate solution for animal is as under-

   Lead monoxide- 87.5 g;
   Distilled water- as required to make 500 ml

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the solution in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- This solution has local sedative, soothing, astringent and antiinflammatory effects, and is applied in sprain, contusion and bruise of tendon/muscle.

3. Calcium Hydroxide Solution:

   Composition- The composition of 500 ml of calcium hydroxide solution for animal is as under-

   Calcium hydroxide- 5.0 g;
   Distilled water- as required to make 500 ml

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the solution in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- It is antiseptic, parasiticide, antacid, gastric sedative and astringent. This is also given in ulcerative stomatitis, skin diseases, hyperacidity and vomiting.
COMPOUNDING AND DISPENSING OF EMULSIONS

OBJECTIVE
To study the preparation and types of emulsions.

EMULSION AND SUSPENSION
“Emulsion” is a heterogeneous system preparation of two immiscible liquids in which one phase (dispersed phase) is dispersed as the fine globules into another phase (dispersion medium), and is stabilized by an ‘emulsifying agent’. An emulsifying agent is necessary in order to prevent the coalescence. In other words, the “emulsion” is a mixture of two liquids, usually oil and water; one of which is dispersed as droplets in the other. The “emulsion” is distinguished from the “suspension” in that the “suspension” is sufficiently large for sedimentation and usually it must be larger than 1 micrometer. In “suspension”, a solid and liquid forms an interface. In other words, the “suspension” is a liquid preparation containing undissolved material. Any “emulsion or suspension” should have a ‘Shake well’ label on the container.

AIMS AND IMPORTANCE OF EMULSION
The emulsion:

- May increase the solubility of drug- many drugs have limited solubility but have excellent activity in solution form; oil phase of emulsion allows the drug to be in the solution form.
- May increase the stability of drug- many drugs are unstable in aqueous solution but much more stable when incorporated into the emulsion form.
- May prolong the action of drug- incorporation of a drug into an emulsion alters
the bioavailability, as with certain intramuscular (im) injection preparations.

- May improve the taste- objectionable medicaments are more palatable in emulsion form, and are thus more conveniently administered.
- May improve the appearance- oleaginous materials intended for topical application are appealing in an emulsified form.

**TYPES OF EMULSION**

1. *Oil in water (O/W)*- The oil droplets are dispersed in water.
2. *Water in oil (W/O)*- The water droplets are dispersed in oil.
3. *Multiple emulsion* - Oil-in-water-in-oil (O/W/O) and water-in-oil-in-water (W/O/W) are the examples of this type.
4. Based on size of liquid droplets-
   - *Macroemulsion (kinetically stable)*- 0.2 to 50 mm size.
   - *Microemulsion (thermodynamically stable)*- 0.01 to 0.2 mm size.

   The lotions, liniments, creams, ointments and vitamin drops are general types of pharmaceutical emulsions.

**METHODS FOR PREPARATION OF EMULSION**

A. Dry Gum Method
B. Wet Gum Method
C. Bottle Method
D. Auxiliary Method
E. *In situ* Soap Method

**EMULSIFYING AGENTS**

The “emulsifying agents” are those agents which reduce the interfacial tension between the two phases, i.e., aqueous phase and oily phase, thus making them miscible with each other and form a stable emulsion. They have hydrophilic and lipophilic portions which increase kinetic stability of emulsions. The emulsions:

1) Should be stable.
2) Should be compatible with other ingredients.
3) Should be non-toxic.
4) Should possess little odour, taste or colour.
5) Should not interfere with the stability of efficacy of the active agent.

The “emulsifying agents” are of different types, which can be classified as follows (Table 11):

**Table 11: Classification and Sources of Various Emulsifying Agents**

<table>
<thead>
<tr>
<th>Emulsifying Agents</th>
<th>Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agar, alginates</td>
<td>Sulphated polysaccharides</td>
<td>Sea weeds</td>
</tr>
<tr>
<td>Gum arabica/gum acacia, gum tragacanth</td>
<td>Neutral polysaccharides</td>
<td>Tree exudates</td>
</tr>
<tr>
<td>Guar gum, quince seed, locust bean</td>
<td>Neutral polysaccharides</td>
<td>Seed extracts</td>
</tr>
<tr>
<td>Bentonite, aluminium magnesium silicate, hectorite, colloidal aluminium and magnesium hydroxides</td>
<td>Neutral polysaccharides</td>
<td>Natural clay</td>
</tr>
<tr>
<td>Xanthan gum</td>
<td>Neutral polysaccharides</td>
<td>Synthetic</td>
</tr>
<tr>
<td>Methyl cellulose, carboxy methyl cellulose</td>
<td>Neutral polysaccharides/ anionic polysaccharides</td>
<td>Cellulose</td>
</tr>
<tr>
<td>Carboxyvinyl polymer, polyvinyl alcohol</td>
<td>Anionic polysaccharides</td>
<td>Synthetic</td>
</tr>
<tr>
<td>Gelatin</td>
<td>Amphoteric proteins</td>
<td>Collagen</td>
</tr>
</tbody>
</table>
COMPOUNDING AND DISPENSING OF ELECTUARIES

OBJECTIVE
To prepare and dispense certain electuaries.

ELECTUARY AND ITS ADVANTAGES
“Electuary” (electuarium) is a semisolid or a pasty preparation, which consists of medicaments incorporated together by adding a suitable excipient like treacle or jaggery at the base. It is intended to be smeared on the back/surface of the tongue or hard palate.

Electuary drug is slowly ingested by the animal. They are mostly used in large animals, and are generally the preferred choice of administration in respiratory diseases. They acquire special importance when large animals are to be given medicines for bronchitis, pharyngitis, tracheitis, etc. in which the wrong drenching of drug solution may result in aspiratory pneumonia and further complications; e.g., expectorant electuary consisting of camphor, ammonium carbonate, belladonna and treacle.

The advantages of electuary over other medicinal preparations are that by electuary:
1) Large quantities of drug/medicament can be administered at a time.
2) Slow release of drug/medicament occurs.
3) Sweetened vehicle produces a sticky solution in the mouth which provides a smoothening and demulcent action.
4) Sweetened vehicle masks the taste of irritant, nauseate drugs.

PREPARATION AND DISPENSING OF CERTAIN ELECTUARIES

1. Antipyretic Electuary:
Composition- The composition of an antipyretic electuary for animal is as under-

Potassium nitrate- 8 g; Sodium chloride- 15 g;
Pulvis chirata- 15 g; Treacle- q.s.

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

Use- It is antipyretic (febrifuge), expectorant, bitter and stomachic, and is indicated in fever associated with respiratory tract infections and other type of fever.

2. Anti-Bronchitis Electuary:

Composition- The composition of the electuary for bronchitis in cow is as under-

Ammonium chloride- 8 g; Glycerrhiza powder- 8 g; Treacle- q.s.

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the mixture in dispensing vial with the labeling instruction of composition, use and dosage.

Use- It is expectorant and soothing, and is indicated in bronchitis, laryngitis and pharyngitis.
COMPOUNDING AND DISPENSING
OF TINCTURES

OBJECTIVE
To prepare and dispense certain tinctures.

TINCTURE AND ITS TYPES
“Tincture” (Tr.) is an alcoholic or hydroalcoholic solution, which contains the active principles of vegetable or animal source of drug. The strength of alcohol may vary from 20 to 90%. The tinctures are comparatively weaker than the extracts. They are very stable preparations, and can be stored for longer time without loss of potency, decomposition or degradation due to preservative action of alcohol in it. The tinctures are generally prepared by ‘maceration’ and ‘percolation’ methods. They should be stored in a well closed container in cool place, away from the light.

The tinctures are of the following types:

1. Simple- When a tincture contains only one ingredient, it is a ‘simple tincture’. For examples, Tr. belladonna and Tr. digitalis.
2. Compound- When a tincture contains more than one ingredient, it is a ‘compound tincture’. For example, Tr. compound benzoin.

PREPARATION AND DISPENSING OF CERTAIN TINCTURES

1. Capsicum Tincture:
   Composition- The composition of 500 ml of capsicum tincture for animal is as follows -
   Capsicum (coarse powder)- 25 g; Alcohol (60%)- add to make 500 ml

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Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the mixture in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- The capsicum tincture is carminative, stomachic and counter-irritant, and is indicated in indigestion, tympany and colic.

2. **Compound Cardamom Tincture:**
   Composition- The composition of 500 ml of compound cardamom tincture for animal is as follows-
   - Cardamom seeds- 7 g; Caraway powder- 7 g; Cinnamon powder- 14 g;
   - Amaranth- 2.5 g; Glycerine- 25 ml; Alcohol (45%)- add to make 500 ml

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the mixture in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- This tincture is used as stimulant, stomachic, carminative, astringent, antiseptic and flavouring agent.

3. **Compound Benzoin Tincture:**
   Composition- The composition of 500 ml of compound benzoin tincture for animal is as follows-
   - Benzoin- 50 g; Storax- 37.5 g; Balsam of tolu- 12.5 g;
   - Aloe- 20.0 g; Alcohol (90%)- add to make 500 ml

Method- Weigh/measure the above chemicals/ingredients and put them in mortar and pestle, and triturate them. Then, dispense the mixture in dispensing bottle with the labeling instruction of composition, use and dosage.

Use- The compound benzoin tincture is a stimulant, antiseptic, parasiticide, expectorant and haemostatic.
ABOUT AUTHOR: DR. GOVIND PANDEY

Dr. Govind Pandey, “Professor/Principal Scientist” of Pharmacology & Toxicology, possesses about 33 yr. of experience in ‘Research/Teaching/Extension/Administration’. He is an able academician, scientist, veterinarian and administrator; a Hindi literalist and eloquent speaker endowed with strong writing flair. Dr. Pandey is probably “Only person in Madhya Pradesh and alone veterinarian in India with maximum academic qualifications” (20 Degrees/Diplomas/Certificates). He obtained PhD (Hons.) in Veterinary Pharmacology & Toxicology from the Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur in 1990. Presently, he is doing DSc. His “Biography” is included in the famous directory/book of the world, “Who’s Who in the World 2011” (28th edition, America). Dr. Pandey is honoured with 3 prestigious ‘Fellowship Titles’, viz., “FASAW, FSLSc and FISCA”.

Dr. Pandey started his career as “Veterinary Assistant Surgeon/Lecturer” on 7th August, 1980 at Artificial Insemination Training Institute, Mandla; followed with “Veterinary Surgeon/Senior Veterinary Surgeon” in different offices at Jabalpur, including “Officer-In-Charge cum Drawing Disbursing Officer (DDO)” of Rinder Pest, Jabalpur Division, Jabalpur under the Animal Husbandry Department, Government of MP. During this period, he also served as “Chief Executive Officer/Block Development Officer cum DDO” of some Janapad Panchayats under the Panchayat & Rural Development Department, Govt. of MP; and as “Assistant Professor & Head, and Professor/Principal Scientist & Head” of Pharmacology in Pharmacy colleges. On 20th April, 2012, he joined as “Deputy Director of Research/Associate Professor/Senior Scientist” at the Directorate of Research Services, Nanaji Deshmukh Veterinary Science University (NDVSU), Jabalpur, MP, India. On 26th November, 2012, he has resumed the post of “Professor/Principal Scientist & Sectional Head”, Department of Pharmacology & Toxicology, College of Veterinary Science & AH, Rewa (NDVSU, Jabalpur).

He is working in different areas of Life Sciences, including Pharmacology & Toxicology and Fishery Science. He has also made a good contribution in Hindi literature, Human Resource Management, Political Science, Sociology, Public Administration, Law and Astrology. Dr. Pandey has investigated some “Antihepatotoxic and anticancer herbal drugs, and experimental hepatotoxic and cancer models” in animals. He has published more than 225 scientific papers and delivered many speeches in conferences/seminars/AIR/governmental or public programmes. He has “Supervised/Guided/Co-Guided” many PhD/PG/UG research scholars for their ‘Thesis/Dissertations/Project Reports’. He has also carried out some ‘Research Projects’. In science, his “1 e-Book and 1 e-Manual” have been recently published by the International E - Publication, ISCA (2013). His “10 scientific Books/Manuals” are likely to be published soon. He has received “30 Awards/Fellowships/Sponsorships/Honours/Recognitions” (including “ICAR Senior Research Fellowship” and “Sri Ram Lal Agrawal National Award”) in science, research and Hindi literature. In Hindi literature, he has published “5 Books”, released “2 Audiocassettes” of own lyrics and edited “1 Book”. His several poems, lyrics,
dramas or stories have been published/broadcasted through various media. He is the “Life Member” of 25 scientific, professional, literary and cultural associations/societies/journals. He has chaired as the “Chairperson/Chief Guest/Judge/Expert” in many conferences/projects/committees/programmes. He has also acted as the “Editor/Mentor/Editorial Board Member/Reviewer” of some books/journals/magazines. Dr. Pandey is “Ex-Captain of Badminton”, “Ex-Sergeant of NCC”, “Ex-Literary Secretary” and “Ex-Hostel Prefect”. He has passed “NCC C Certificate”; and “2 years’ Course of National Service Scheme” (NSS).